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BULLETIN 313

BIOSTRATIGRAPHY AND PALEONTOLOGY OF MIDDLE-UPPER DEVONIAN BOUNDARY BEDS, GYPSUM CLIFFS AREA, NORTHEASTERN ALBERTA

A.W. NORRIS
T.T. UYENO

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Preface

The faunas of the Slave Point Formation and Peace Point Member of the Waterways Formation are of special significance because they straddle the Middle-Upper Devonian boundary as interpreted and accepted in western Canada. The definition of the Middle-Upper Devonian boundary is still unresolved but is currently receiving special attention from members of the Subcommission on Devonian Stratigraphy of the International Commission on Stratigraphy in an attempt to reach international agreement on the placement of this and other series and stage boundaries within the Devonian.

This report describes and illustrates two of the important Devonian fossil groups of the Slave Point Formation and Peace Point Member outcropping at Gypsum Cliffs on Peace River in northeastern Alberta. It is based on fossil collections made in 1977 and 1961 and incorporates detailed field observations made in 1956.

The study of brachiopods by Dr. Norris and conodonts by Dr. Uyeno provides independent dating of these boundary beds and will assist in precise correlation with other areas in North America and elsewhere regardless of the criteria ultimately selected internationally to mark the Middle-Upper Devonian boundary. Such correlations have long term significance in the exploration for fuels and minerals.

R.A. Price
Director General
Geological Survey of Canada

Ottawa, May 1982.

Préface

Les faunes fossiles de la formation de Slave Point et du niveau de Peace Point de la formation de Waterways présentent un intérêt particulier en raison du fait qu'elles chevauchent la limite entre les couches du Dévonien moyen et du Dévonien supérieur, ainsi qu'interprétée et acceptée dans l'Ouest du Canada. La question de la définition exacte de la limite entre ces couches demeure irrésolue mais fait présentement l'objet d'une attention toute spéciale de la part des membres de la Sous-commission de la stratigraphie dévonienne relevant de la Commission Stratigraphique Internationale. Ces derniers cherchent à en arriver à un accord international en ce qui a trait à la question de l'emplacement, à l'intérieur du Dévonien, non seulement de la dite limite mais également des couches limites d'autres séries et étages.

Le présent bulletin décrit et illustre deux des groupes de fossiles dévoniens importants provenant des affleurements de la formation de Slave Point et du niveau de Peace Point, à Gypsum Cliffs sur la rivière de la Paix, dans le nord-est de l'Alberta. Il se fonde en outre sur des collections de fossiles assemblées en 1977 et 1961 et a également recours à des observations détaillées faites sur le terrain en 1956.

L'étude des brachiopodes et des conodontes, réalisée par MM. Norris et Uyeno respectivement, fournit des données indépendantes relatives à l'âge de ces couches limites. Elle contribuera en outre à établir la corrélation qui existe entre ces dernières, et d'autres régions d'Amérique du Nord et ailleurs, sans se préoccuper des critères éventuellement choisis par la communauté internationale pour définir la limite entre les couches du Dévonien moyen et du Dévonien supérieur. L'établissement de telles corrélations est d'une grande importance pour les activités de recherche des minéraux et des combustibles fossiles.

R.A. Price
Directeur général
Commission géologique du Canada

mai 1982, Ottawa

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BIOSTRATIGRAPHY AND PALEONTOLOGY OF MIDDLE-UPPER DEVONIAN BOUNDARY BEDS, GYPSUM CLIFFS AREA, NORTHEASTERN ALBERTA

Abstract

Three Devonian rock units outcrop at Gypsum Cliffs comprising, in ascending sequence: gypsum of the Fort Vermilion Formation; limestone and dolomitic limestone, commonly brecciated, of the Slave Point Formation; and calcareous shale with thin intercalated limestone beds of the Peace Point Member of the Waterways Formation preserved in sinkholes and erosional cavities in the Slave Point Formation.

The Fort Vermilion is unfossiliferous but occurs above the highest level of *Stringocephalus* in western Canada. The Slave Point contains a meagre megafauna characterized by *Emanuella vernilis* Crickmay in the lower part and *Desquamatia (Independatrypa)* sp. cf. *D. (I.) independensis* (Webster) in the upper beds. The latter megafauna is associated with a conodont fauna of low diversity comprising *Polygnathus brevilaminus* Branson and Mehl, *Icriodus subterminus* Youngquist, and possibly *Ozarkodina semialternans* (Wirth), which is interpreted as a shallow water biofacies of the *Schmidtognathus hermanni – Polygnathus cristatus* Zone. The Peace Point beds contain a rich brachiopod fauna including *Ladogioides pax* McLaren, *Platyterorhynchus russelli* (McLaren), *Tecnocyrtina billingsi* (Meek) and *Eleutherokomma impennis* Crickmay as its more diagnostic forms. Associated conodonts are moderately abundant and belong to the *Pandorinellina insita* fauna which is probably assignable to the Lowermost *Polygnathus asymmetricus* Zone. The base of this zone has commonly been accepted as the base of the Upper Devonian in western Canada.

New brachiopod taxa from the Peace Point Member comprise *Platyterorhynchus russeli* new form A, *Desquamatia (Variatrypa) klukasi* n. sp., and *Pseudoatrypa devoniana boyeri* n. ssp.

Résumé

Les roches du Dévonien qui affleurent à Gypsum Cliffs, comprennent de bas en haut: le gypse de la formation de Fort Vermilion; les calcaires et les calcaires dolomitiques, généralement bréchiques, de la formation de Slave Point; les shales calcaires à minces intercalations calcaires du membre de Peace Point de la formation de Waterways, qui ont été préservés dans des collines et des cavités d'érosion formées à l'intérieur de la formation de Slave Point.

La formation de Fort Vermilion n'est pas fossilifère mais elle est située au-dessus du niveau le plus élevé à *Stringocephalus* de l'ouest du Canada. La formation de Slave Point contient une macrofaune peu abondante caractérisée par *Emanuella vernilis* Crickmay dans sa partie inférieure, et par *Desquamatia (Independatrypa)* sp. cf. *D. (I.) independensis* (Webster) dans les lits supérieurs. Cette dernière macrofauna est associée à une faune de conodontes peu diversifiée comprenant *Polygnathus brevilaminus* Branson et Mehl, *Icriodus subterminus* Youngquist, et probablement *Ozarkodina semialternans* (Wirth), dont on considère qu'elle appartient à un biofaciès d'eau peu profonde de la zone *Schmidtognathus hermanni – Polygnathus cristatus*. Les lits de Peace Point contiennent une riche faune de brachiopodes, en particulier *Ladogiodes pax* McLaren, *Platyterorhyncus russelli* (McLaren), *Tecnocyrtina billingsi* (Meek) et *Eleutherokomma impennis* Crickmay, qui sont les meilleurs formes de diagnostic. Les conodontes associés à cette faune sont moyennement abondants et appartiennent à la fauna à *Pandorinellina insita* que l'on peut sans doute attribuer à la zone la plus basse à *Polygnathus asymmetricus*. La base de cette zone est généralement acceptée comme la base du Dévonien supérieur dans l'ouest du Canada.

Parmi les nouveaux taxons de Brachiopodes du membre de Peace Point, citons une nouvelle forme A de *Platyterorhynchus russeli*, une nouvelle espèce *Desquamatia (Variatrypa) klukasi*, et une nouvelle sous-espèce *Pseudoatrypa devoniana boyeri*.

INTRODUCTION

Purpose

The rock succession exposed in the Gypsum Cliffs area on lower Peace River, northeastern Alberta, is one of the few places in the Interior Plains region of western Canada where rocks straddling the traditionally accepted Middle-Upper Devonian boundary for this area can be examined at the surface. One of the objectives of the Subcommission on Devonian Stratigraphy, which was created in 1973, is to reach international agreement on the placement of series and stage boundaries. Therefore, any section that may shed new light on the faunas in the Middle-Upper Devonian boundary beds to assist in dating and correlation with other areas is of prime importance. Unfortunately, the megafaunas in the Slave Point Formation are exceedingly sparse and poorly preserved, but a rich megafauna occurs in the overlying Peace Point Member of the Waterways Formation. The brachiopods of this latter fauna are described and illustrated as a more or less complete assemblage for the first time. Conodonts from both the Slave Point Formation and Peace Point Member of the Waterways Formation at Gypsum Cliffs are also described and illustrated to provide an independent dating of the beds.

Location

Exposures of Devonian rocks in the Gypsum Cliffs area (see Norris, 1963, Fig. 11) extend discontinuously along the lower Peace River in northeastern Alberta for a river distance of approximately 29.8 km. They extend from a point 4 km above (south of) the southwest tip of an unnamed island opposite Boyer Rapids to a point about opposite the midlength of a large unnamed island 9.3 km river distance downstream from the ranger cabins at Peace Point (Fig. 2). The name Peace Point, according to Sir Alexander Mackenzie (in Craig, 1928, p. 100) records the place where the Cree and Beaver Indians settled a dispute over territory. The name Gypsum Cliffs refers to the light-coloured gypsum deposits of the Fort Vermilion Formation that form a conspicuous part of the Devonian succession in this area. This stretch of Peace River, shown in the Peace Point map sheet (NTS 84P), flows through townships 116 and 117, and ranges 14 to 16 west of the 4th meridian. Peace Point, on the north bank of Peace River, is now connected with Fort Smith to the north-northeast by an all-weather gravelled road 115.9 km long. Fort Smith is located at the lower end of the rapids on Slave River in the southern District of Mackenzie immediately north of the northern boundary of Alberta. It is in turn connected by an all-weather gravelled road to Pine Point, Hay River and the Mackenzie Highway. The nearest large settlement to the southeast is Fort Chipewyan located at the northwest end of Lake Athabasca, an air distance of about 72.4 km from Peace Point.

Previous geological investigations

Macoun (1877, p. 89, 90) in 1875 travelled down the Peace River and later presented a short geological account of observations of the Gypsum Cliffs exposures. The rapids near the upper end of the exposures were then referred to as Rapid Bouillé, which subsequently were referred to as Little Rapids and later named Boyer Rapids. He mentioned the gypsum as being overlain by a light grey granular rock. Fossils collected from contorted and brecciated limestone (Peace Point beds) at the head of Boyer Rapids were examined by Whiteaves (1877, p. 104) and dated as Devonian.

Camsell (1917a, p. 136, 137, 139, 140) examined the Gypsum Cliffs section in 1916 and recognized three Paleozoic rock units comprising a lower unit of gypsum; a middle unit of brecciated dolomite; and an upper unit of argillaceous, in part sandy, limestone containing fossils that were dated as Middle Devonian. The fossils were collected from two localities, the first from a point on the south bank of Peace River near the foot of Little (Boyer) Rapids, and the second from the north bank of the river at the head of the rapids.

Kindle (in Cameron, 1922, p. 17) examined the Gypsum Cliffs section in 1917 and found a few fossils in the brecciated dolomite unit which he dated as Silurian. Both the brecciated dolomite containing the few fossils and the

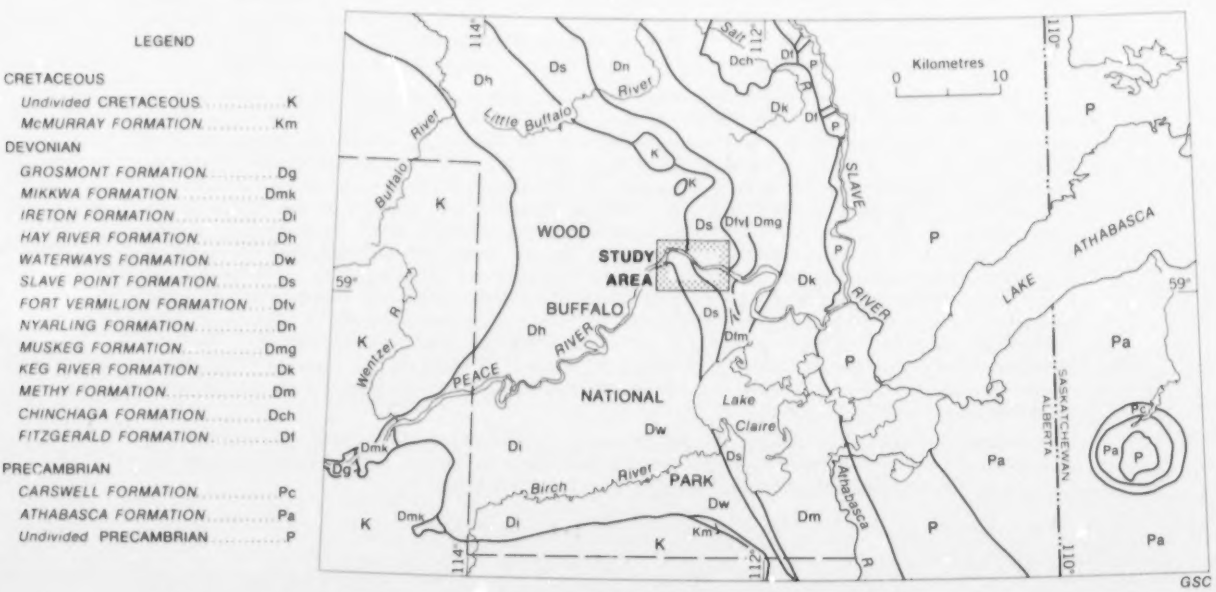


Figure 1. *Map showing location of Gypsum Cliffs area, general geology of northeastern Alberta and northwestern Saskatchewan, and distribution of Devonian rocks.*

underlying gypsum beds were referred to as the "Gypsum series" and considered to be of Silurian age. Fossils derived from argillaceous beds found in erosional and solution cavities in the "Gypsum series" were considered to be equivalent to the Ithaca phase of the Portage of New York. From this evidence, Kindle postulated an erosional unconformity between the "Gypsum series" and succeeding beds.

The report by Kindle (1928, p. 14 - 18) provided the most detailed and perceptive account of the stratigraphy and faunas of the Gypsum Cliffs section up to that date. From a section at the south tip of the unnamed island opposite Boyer Rapids, Kindle collected sparse and poorly preserved fossils from a thin sequence of thin-bedded, drab, slightly magnesian limestone capping the section and overlying evaporites. The fossils comprised *Spirifer crispus* (Hisinger), *Modiolopsis* sp., and *Modiolopsis* sp. cf. *M. orthonota* (Conrad), which he dated as Late Silurian. Kindle assumed that the beds containing this fauna represented the youngest member of the dolomitic formation named the Fitzgerald dolomitic limestones by Cameron (1918, p. 25). The richly fossiliferous blue shale and thin beds of limestone unconformably overlying the "Fritzgerald beds" were named the Peace Point beds. He listed 18 species of fossils from the Peace Point beds collected from two localities, which he dated as early Late Devonian, and postulated that the Peace Point beds represented a nearshore facies and were contemporaneous with the Simpson Shale to the northwest. The fossils listed by Kindle (1928, p. 16) from the Peace Point beds comprise the following (a---abundant; c---common; r---rare):

crinoid stems	c
Aulopora sp. cf. *A. adnascens* Fenton	r
Spirorbis omphaloides Goldfuss	c
Crania sp.	r
Schizophoria striatula (Schlotheim)	c
Camarotoechia sp.	r
Pugnax pugnus Martin var.	c
Leiorhynchus mesacostale Hall	c
Atrypa reticularis (Linn.)	a
Atrypa sp. cf. *A. spinosa* Hall	r
Cyrtina hamiltonensis Hall var.	r
Cyrtina billingsi Meek	c
Cyrtina billingsi var. *symmetrica* n. var.	r
Spirifer tullia var. Whiteaves	c
Palaeoneilla filosa (Conrad)	r
Leda sp. cf. *L. diversa* (Hall)	r
Modiomopha sp. undet.	r
Leptodesma sp. cf. *L. naviforme* Hall	r

Cameron (1930, p. 39 - 47) in 1929 investigated the economic possibilities of the gypsum deposits at Gypsum Cliffs for the Scientific and Industrial Research Council of Alberta. He presented descriptions of 10 measured and sampled sections, five of which included carbonate beds (Slave Point Formation) overlying the gypsum, but did not mention the Peace Point beds.

Bassett (1952MS, p. 112 - 115) presented a composite section of the stratigraphic succession in the Gypsum Cliffs area, which he interpreted from a number of discontinuous measured sections. A thin sequence of bluish green shale at the top of the sequence was correlated with the lower Waterways Formation. The underlying, in part brecciated, dolomitic limestone was correlated with the Slave Point Formation of the Great Slave Lake area and with a thin carbonate unit immediately underlying the Waterways Formation in the Athabasca - Clearwater rivers area.

Govett (1961, p. 32 - 36) summarized the stratigraphic information on the gypsum of Gypsum Cliffs area based largely on the work of Cameron (1930) and an unpublished report by Halferdahl (1960). Govett's (1961) report includes facies and structural cross sections, and an isopach map for the Elk Point Group of Alberta. Fossils collected by Halferdahl (1960, p. 4, 5) from green shale (Peace Point beds) at the tops of the cliffs from both the north and south banks of Peace River near the western end of the gypsum outcrops were identified by P.S. Warren and correlated with the lower

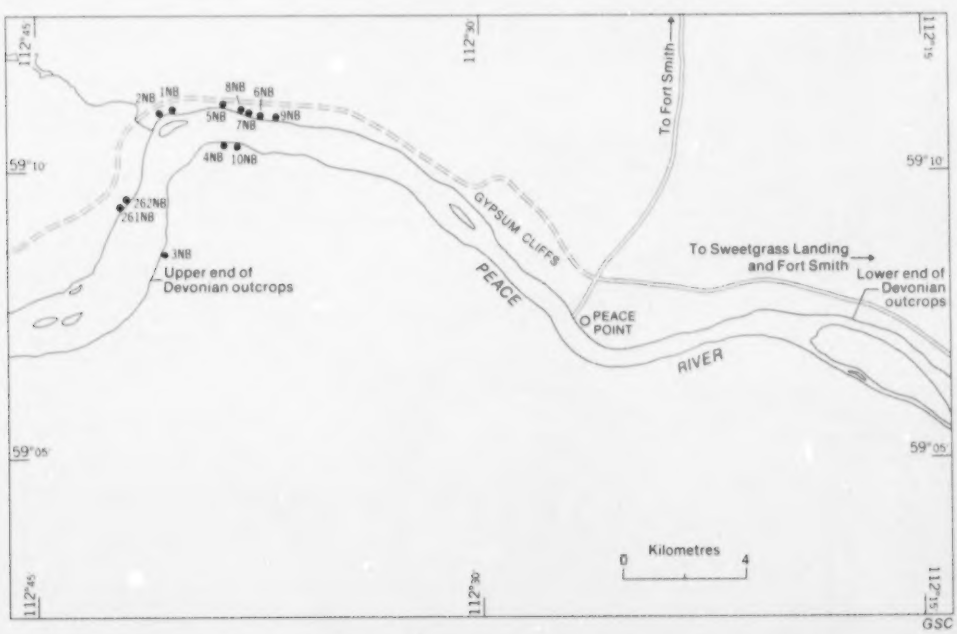


Figure 2. *Map showing station localities of Sections 1 and 2, Gypsum Cliffs area, Peace River, Alberta.*

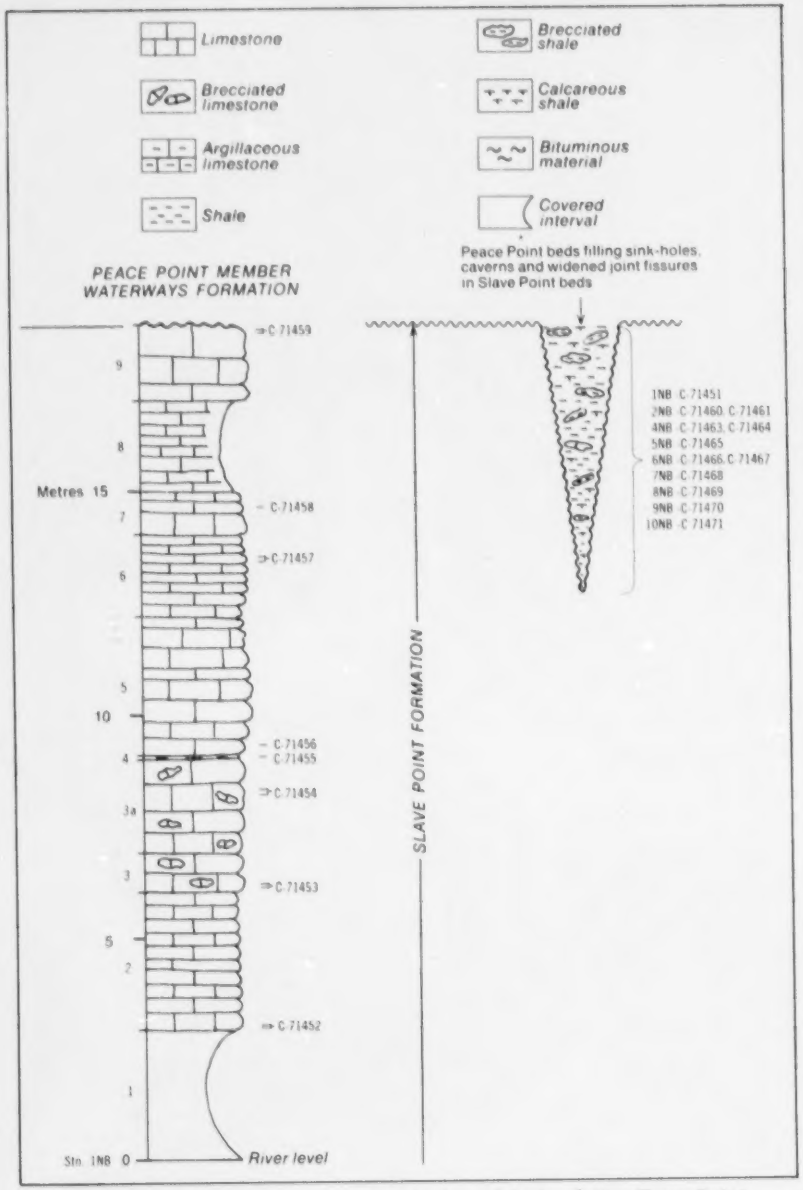


Figure 3. *Diagrammatic representation of beds of the Slave Point Formation and Peace Point Member of the Waterways Formation exposed at Station 1NB (Sec. 1), Gypsum Cliffs area, Peace River, Alberta.*

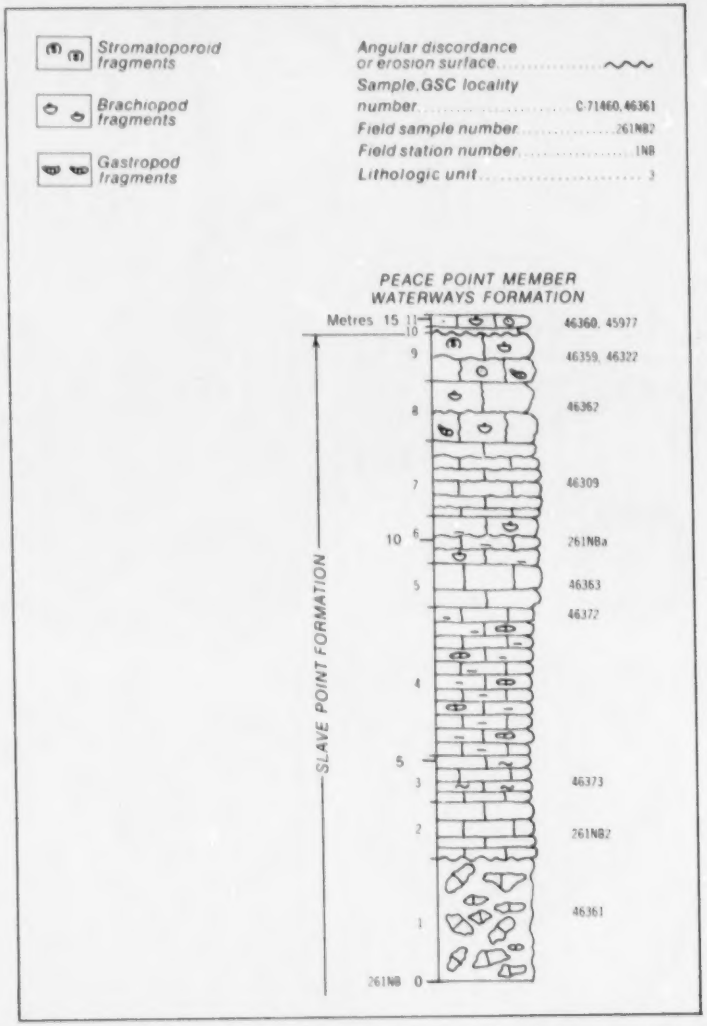


Figure 4. *Diagrammatic representation of beds of the Slave Point Formation and Peace Point Member of the Waterways Formation exposed at Station 261NB and 262NB (Sec. 2), Gypsum Cliffs area, Peace River, Alberta.*

part of the Waterways (Beaverhill Lake) Formation. These comprise the following:

Atrypa sp. aff. *A. clarkei* Warren
Atrypa sp. cf. *A. independensis* Webster
Cyrtina billingsi Meek
Eleutherokomma sp.
Leiorhynchus sp.
Pugnax sp.
Schizophoria sp. cf. *S. athabascensis* Warren

McLaren et al. (1962, p. 22, Pl. 10, figs. 11 - 20) illustrated three species of brachiopods from beds of the Peace Point Member of the Waterways Formation outcropping at Gypsum Cliffs comprising *Ladogioides pax* McLaren, *Leiorhynchus* sp. (=*Platyterorhynchus russelli* (McLaren)), and *Eleutherokomma impennis* Crickmay.

McLaren (1962) described two new species of rhynchonelloid brachiopods, *Ladogioides pax* McLaren and *Platyterorhynchus russelli* (McLaren), from the Peace Point Member of the Waterways Formation of the Gypsum Cliffs area, based on material collected in 1956 by Norris (1963).

Norris (1963, p. 58 - 67, 124 - 131) presented the most detailed account of the geology, stratigraphy, and faunal distribution of the Devonian succession exposed at Gypsum Cliffs based on field work done in 1956. The lower unit of gypsum was referred to the Fort Vermilion Formation; the middle unit of carbonate and brecciated carbonate was assigned to the Slave Point Formation; and the upper unit of shale and some thin-bedded limestone was named the Peace Point Member of the Waterways Formation. This report includes detailed descriptions of selected measured sections for each of the rock units comprising: Fort Vermilion Formation---5 sections; Slave Point Formation---8 sections; and Peace Point Member---5 sections.

Norris (1965, Fig. 3; 1973, Fig. 3) showed the relationship of the Devonian succession exposed at Gypsum Cliffs on the lower Peace River to that exposed to the northeast along Slave River in northeastern Alberta.

Crickmay (1966, p. 16, 17) presented a composite section of the Devonian rocks exposed at Gypsum Cliffs, which he subdivided into four rock units and interpreted as follows, in ascending sequence:

1. A lower unit of deformed gypsum (60.9 m exposed) representing the upper part of the Elk Point Group and separated by an angular unconformity from overlying beds.

2. Collapsed and brecciated, buff to pale chocolate, fine-grained, in part silty limestone (9.1±m thick) assigned to the Slave Point Formation. Fossils recorded were assigned to the *vernilis* Zone and comprise:

Spinatrypa sp. aff. *S. albertensis* Warren
Atrypa sp. aff. *A. independensis* Webster
Ambothyris sp.
Emanuella sp. S (=*Emanuella vernilis* Crickmay, 1967)
Leptodesma sp.

3. Buff, coarse-grained limestone, involved in complex collapse brecciation with some deposition brecciation (30.5±m thick) assigned to the Swan Hills Formation. Fossils recorded were assigned to the *independensis* Zone and comprise:

Clathrodictyon sp.
Stromatopora sp.
Atrypa sp. cf. *A. independensis* Webster

4. Grey calcareous shale (0 - 9.1 m represented) occurring in collapsed pockets in the underlying breccia and considered a part of the Waterways Formation. Fossils recorded were assigned to the *impennis* Zone and comprise:

Leiorhynchus russelli McLaren
Spinatrypa sp. cf. *S. mascula* Stainbrook
Ladogioides pax McLaren
Atrypa sp. cf. *A. littletonensis* Fenton and Fenton
Eleutherokomma aechmophora Crickmay
Schizophoria sp. cf. *S. lata* Stainbrook
Cyrtina billingsi Meek
Myalina sp.

On a geological map of Alberta, Green (1972), following the usage of some workers, subdivided the Slave Point Formation in the Gypsum Cliffs area into two members, a lower evaporite unit referred to the Fort Vermilion Member, and an upper carbonate unit which he named the Caribou Member. The latter term, however, has not gained general acceptance.

Present work

Two sections of the Slave Point Formation were investigated in detail comprising Section 1 at Station 1NB and Section 2 at Stations 261NB and 262NB (Figs. 2 - 4 and Appendix). Section 1 is one of the thicker, more complete and unbrecciated sequences of Slave Point beds in the Gypsum Cliffs area. Section 2 is one of the few sections in the area where the Slave Point beds contain megafossils, and is exposed only when the water level of Peace River is unusually low (August, 1961).

The study of the brachiopods of the Peace Point Member of the Waterways Formation is based on collections made in 1977 from 9 out of a total of 14 or so known outcrops of these beds in the area (see Norris, 1963, Fig. 11, geological map). This sampling provided an almost complete assemblage of forms known to be present in the Peace Point beds.

The study of the conodonts is based on 15 samples from the Slave Point Formation and 3 from the Peace Point Member of the Waterways Formation at Sections 1 and 2.

This report is a collaborative effort between the two authors in which the work was apportioned as follows: A.W. Norris is responsible for the field observations and fossil collections, stratigraphy of the rock units, and systematic paleontology and biostratigraphy of the brachiopods; and T.T. Uyeno is responsible for the systematic paleontology and biostratigraphy of the conodonts.

Acknowledgments

During the 1961 field season, Norris was ably assisted by P.A. Bolton, and in 1977 by A.E.H. Pedder. Fossil collections from the Gypsum Cliffs area were made under Parks Canada Collection Permit No. 77-11 for Wood Buffalo National Park. Officers of Wood Buffalo National Park at Fort Smith were exceedingly helpful in providing information on accessibility of roads and other information pertaining to the park. The brachiopods illustrated in this report were photographed by B.C. Rutley and W.B. Sharman of the Geological Survey of Canada. The writers are indebted to D.G. Perry and D. Schumacher for critically reading the manuscript and offering helpful suggestions---many, but not all, of these have been incorporated in the text.

STRATIGRAPHY

Geological setting

Following the terminology of Bassett and Stout (1968, p. 719, Fig. 2) for the regional framework of the Devonian of western Canada, the Gypsum Cliffs deposits are within the extreme southeastern part of the Hay River Basin. This basin is bounded on the east by the Canadian Shield, on the south by the Peace River - Athabasca Arch, on the west by the Rocky Mountains of British Columbia, and on the northwest by the Tathlina High. Throughout this area, the Devonian succession rests on Precambrian crystalline rocks or small erosional remnants of Middle Cambrian sedimentary rocks (Bassett and Stout, 1968, p. 731, Fig. 7). The precise thickness of the preserved Devonian succession in the Gypsum Cliffs area is unknown, because of a lack of drillholes in Wood Buffalo National Park, but it is estimated to be approximately 275 m (Norris, 1963, p. 56, Fig. 10). Of this total thickness, approximately 50.3 m are represented in outcrops at Gypsum Cliffs.

The Devonian succession exposed at Gypsum Cliffs comprises the following in ascending sequence: evaporites of the Fort Vermilion Formation, carbonates of the Slave Point Formation, and shale and some interbedded limestone of the Peace Point Member of the Waterways Formation. The relationship and lithology of these rock units are shown diagrammatically in Figure 5 based on 10 selected sections measured and described by Norris (1963, p. 124 - 131). Throughout most of the 29.8 km stretch of Peace River where these units are exposed, the beds are in part highly contorted and commonly brecciated due to solution of the gypsum and perhaps of an underlying salt bed resulting in collapse of overlying beds (Govett, 1961, p. 33). Smaller scale folds and contortions may be due to a volume increase because of hydration of anhydrite.

Sinkholes in the overburden testify to the presence of evaporites both north and south of Gypsum Cliffs. The nearest Devonian outcrops to those of Gypsum Cliffs are along the Slave River 72.4 km to the east (Norris, 1963, p. 42 - 57); at and near Vermilion Chutes on Peace River 136.8 km to the southwest (Norris, 1963, p. 68 - 74) and on the southwest side of Lake Claire about 80.5 km to the south-southeast, where outcrops of carbonate beds occur, which were assigned to the Slave Point Formation (Green, 1972). In the third area, southwest of Lake Claire, fossiliferous beds of the Waterways Formation are known to outcrop along the lower part of Birch River (Norris, 1963, p. 66), but these remain to be investigated.

Fort Vermilion Formation

Law (1955a; 1955b, p. 1945) introduced the term Fort Vermilion Member of the Slave Point Formation for 7 m of anhydrite and dolomite at the base of the Slave Point Formation in the type California Standard Steen River 2-22-117-5-W6M well in northwestern Alberta. Norris (1963, p. 59) extended the term Fort Vermilion to the Gypsum Cliffs area and raised it to formational rank. In the latter area, the Fort Vermilion Formation applies to the sequence of evaporites conformably underlying the limestone and dolomitic limestone of the Slave Point Formation. These

TABLE OF DEVONIAN FORMATIONS*

Erathem	Series, or Stage	Formation and Thickness (metres)	Member and Thickness (metres)	Lithology
Cenozoic	Quaternary and Recent			Gravel, sand, silt and clay and soil
Erosional unconformity				
Paleozoic	Upper Devonian	Waterways	Peace Point (0 - 6.1+ m)	Greenish gray calcareous shale and greenish grey argillaceous lime-limestone; abundantly fossiliferous; preserved in cavities such as joint fissures and sinkholes in the Slave Point Formation
	Unconformity			
	Middle Devonian	Slave Point (20.4 ± m)		Medium brown calcarenitic and micritic limestone and dolomitic limestone; some gypsum and minor bituminous shale; in places highly brecciated; sparsely fossiliferous
		Fort Vermilion (22.9+ m)		Gypsum, some anhydrite and dolomitic limestone and minor shale; unfossiliferous

*Modified from Norris, 1963, p. 60.

evaporites are the lowest rocks outcropping in the Gypsum Cliffs area and the contact with underlying beds is not exposed. Without boreholes in the immediate vicinity it is not known if the evaporites of the Fort Vermilion Formation are separated by the Watt Mountain Formation or by equivalent beds from the underlying evaporites which are approximately equivalent to the Muskeg Formation of northwestern Alberta. It is possible that a very thin Watt Mountain Formation, or equivalent beds analogous to the Amco Shale of the Pine Point area, are exposed in the area but remain undetected. In the area north of the northern boundary of Alberta and south of the Pine Point area, the name Nyarling Formation was applied by Norris (1965, p. 62, 63, Fig. 3) to the evaporites underlying the Slave Point Formation.

From the type area of northwestern Alberta, the Fort Vermilion has been traced northward in the subsurface by Belyea and Norris (1962) to the Shell Alexandra No. 2 well (60°24'31"N, 117°55'34"W) on the southern flank of the Tathlina High where it is 6.1 m thick. Eastward of the type well, the anhydrite of the Fort Vermilion thickens to 36.6 m in the Hudson Bay No. 1 Fort Vermilion well (32-104-8-W5M) (Hemphill et al., 1970, p. 62). Southward, in the Swan Hills area of west-central Alberta, Hemphill et al. (1970) show a thin evaporitic Fort Vermilion Formation underlying the reefoid Swan Hills Formation and overlying the clastic Watt Mountain Formation. Just beyond the eastern margin of the Swan Hills reef development, the Fort Vermilion is replaced by carbonates of the Slave Point Formation.

The gypsum deposits of the Fort Vermilion Formation are the most widely distributed in the Gypsum Cliffs area. The thicker sections of gypsum occur in the western third of the area where maximum exposed thicknesses of about 23 m were noted at two localities by Norris (1963, p. 50 - 60), along the east bank of Peace River opposite and upstream from Boyer Rapids, and on the north bank of Peace River 8 km downstream from the east tip of the unnamed island at the lower end of Boyer Rapids.

The economic possibilities of the gypsum at Gypsum Cliffs has attracted considerable interest and for this reason the lithology of the Fort Vermilion Formation has been investigated in more detail than any of the other rock units. The more detailed descriptions include those by Cameron (1930), Halferdahl (1960), Govett (1961, p. 33 - 36) and Norris (1963, p. 61). The lithology consists mainly of whitish grey, evenly thin- to thick-bedded gypsum generally containing thin interbeds and laminae of varicoloured bluish grey and light brown gypsum. Texture of the gypsum varies laterally and vertically from dense and relatively hard to coarse, soft and saccharoidal. Thin sequences up to 0.8 m thick of light brown, fine- to medium-grained, evenly thin-bedded limestone and dolomitic limestone commonly containing inclusions of gypsum occur at scattered intervals. Light olive-grey clay present as discontinuous laminae and very thin beds was noted in some sections. Some anhydrite is present as thin beds and as nodular residuals within the gypsum. Microscopic details of the gypsum, minor anhydrite and dolomite of the Fort Vermilion Formation were presented by Halferdahl (1960) and Govett (1961, p. 35).

The incompetent evaporites are in places strongly contorted, brecciated and faulted as indicated by Norris (1963, Fig. 11), caused presumably by solution and collapse of beds. On evidence from disturbed sections, some authors, notably Crickmay (1957, p. 10), have suggested that there is an unconformity between strata of the Fort Vermilion Formation and overlying Slave Point Formation. In sections showing little or no deformation, the contact is structurally conformable. In addition, lithological similarities in the boundary beds between the Fort Vermilion and Slave Point formations strongly suggest a transitional boundary rather than a hiatus between the two rock units. On this evidence, the units are interpreted by Norris as being conformable.

The evaporites of the Fort Vermilion Formation were formed as the result of a slight regression of the sea, accompanied by low rainfall and a semiarid climate (Jansa and Fischbuch, 1974, p. 43). On a regional basis, Griffin (1965a) postulated that the Fort Vermilion was deposited during the final oscillatory regressive phase before the succeeding main carbonate Slave Point transgressive phase began.

Slave Point Formation

The name Slave Point Formation is applied to the limestone, dolomite and dolomitic limestone, in places strongly brecciated, overlying the evaporites of the Fort Vermilion Formation and underlying greenish grey shales and thin-bedded limestones of the Peace Point Member of the Waterways Formation in the Gypsum Cliffs area. The name "Slave Point limestones" was introduced by Cameron (1918, p. 25, 26) for the upper part of the Middle Devonian succession on the north and west shores of the west arm of Great Slave Lake. Changes in the usage of the term in the Great Slave Lake and adjacent areas are discussed by Belyea and Norris (1962), Norris (1965), and Griffin (1965a). The term Slave Point Formation was extended into the subsurface of northeastern Alberta by Law (1955a, b) and approximately the same usage was continued into northeastern British Columbia by Belyea and Norris (1962) and Gray and Kassube (1963). The Slave Point Formation was traced in the subsurface by Griffin (1965a) from northeastern British Columbia across northern Alberta to the McMurray area.

In the Gypsum Cliffs area, the rock unit designated as the Slave Point Formation was referred to by Crickmay (1957, p. 10) and Warren (1957, p. 1, 2, 5), and later described in more detail by Norris (1963, p. 61 - 64) and Crickmay (1966, p. 16, 17).

The thickness of the Slave Point Formation immediately west of the lower stretch of Buffalo River on the south side of Great Slave Lake in the southern District of Mackenzie is about 61 m. Throughout northeastern British Columbia, it varies between 61 and 152 m. Westward it passes by sharp facies change to shale, and southward it wedges out against the Peace River Arch. Southeastward, across northern Alberta, it thins from 39 m in the Imperial Yates River well (16-18-126-14-W5M) to 1.7 m in the Bear Biltmore No. 1 well (7-11-87-17-W4M) near Fort McMurray. In the California Standard Mikkwa well (12-23-98-21-W4M), located about 185 km south-southwest of Peace Point, the Slave Point Formation is about 12 m thick (see Griffin, 1965a, Figs. 5 - 7).

The maximum exposed thickness (incomplete) of the Slave Point Formation in the Gypsum Cliffs area is close to 21 m. The thicker sequences of the Slave Point occur near the western end of the exposures just below Boyer Rapids. In Section 137NB (see Fig. 5), showing contacts with both underlying and overlying beds, a thickness of about 15 m was measured, suggesting that the top of the Slave Point is an irregular surface and possibly subjected to pre-Waterways erosion.

The Slave Point Formation is mainly light to dark brown, fine- to medium-grained, thin- to thick-bedded, commonly laminated, calcarenitic limestone, weathering light brown, orange-brown and medium brownish grey. In some sections, the limestone contains thin intercalations of dark brown shale. Lenses of bluish grey chert up to about 2.5 cm thick intercalated with the limestone were seen in one section. A sequence of calcareous dolomite, laminated dolomite, and fissile argillaceous dolomite up to about 6 m thick occurs at the base of the formation in some sections; in other sections the basal beds consist of limestone or brecciated limestone.

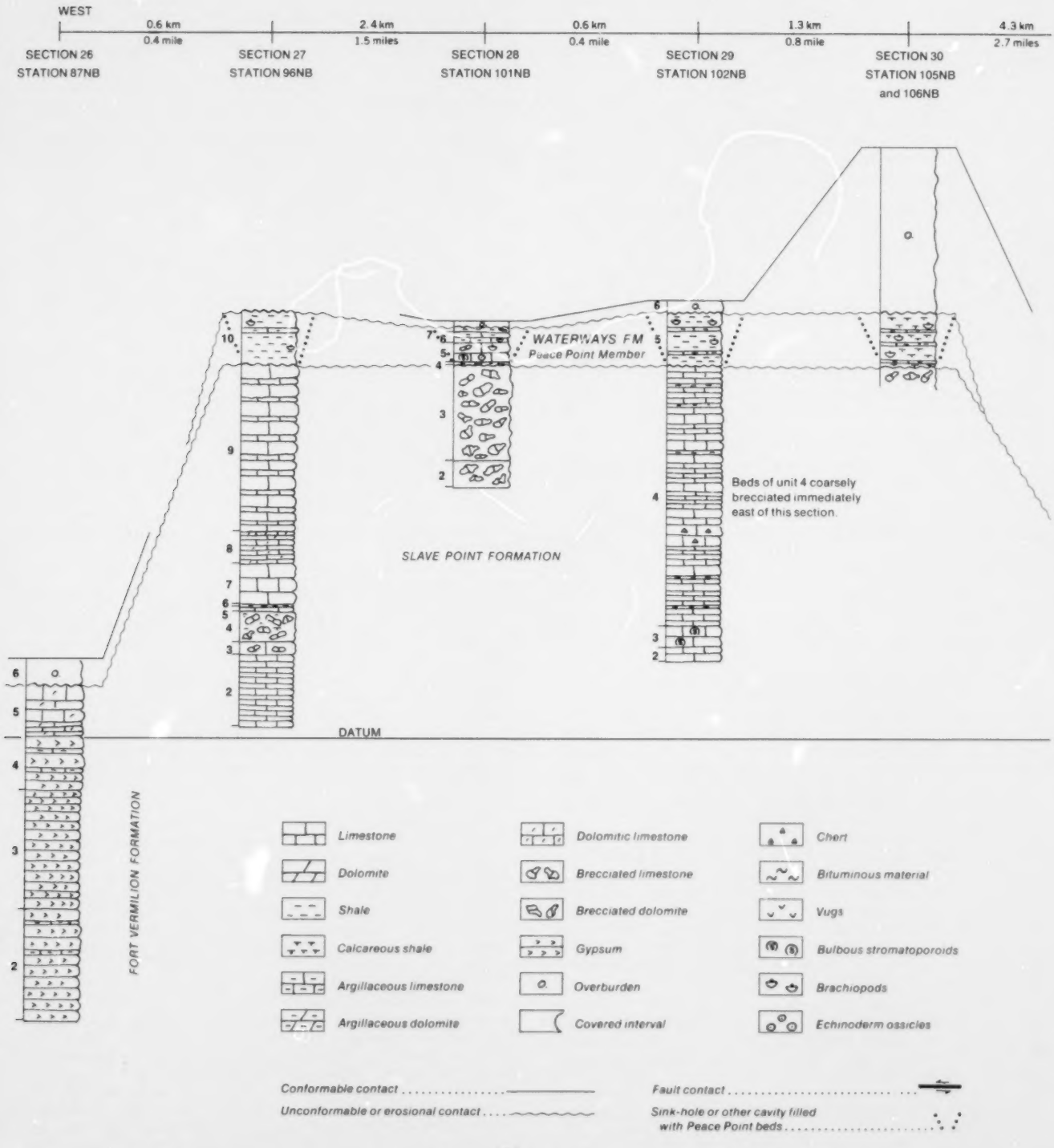
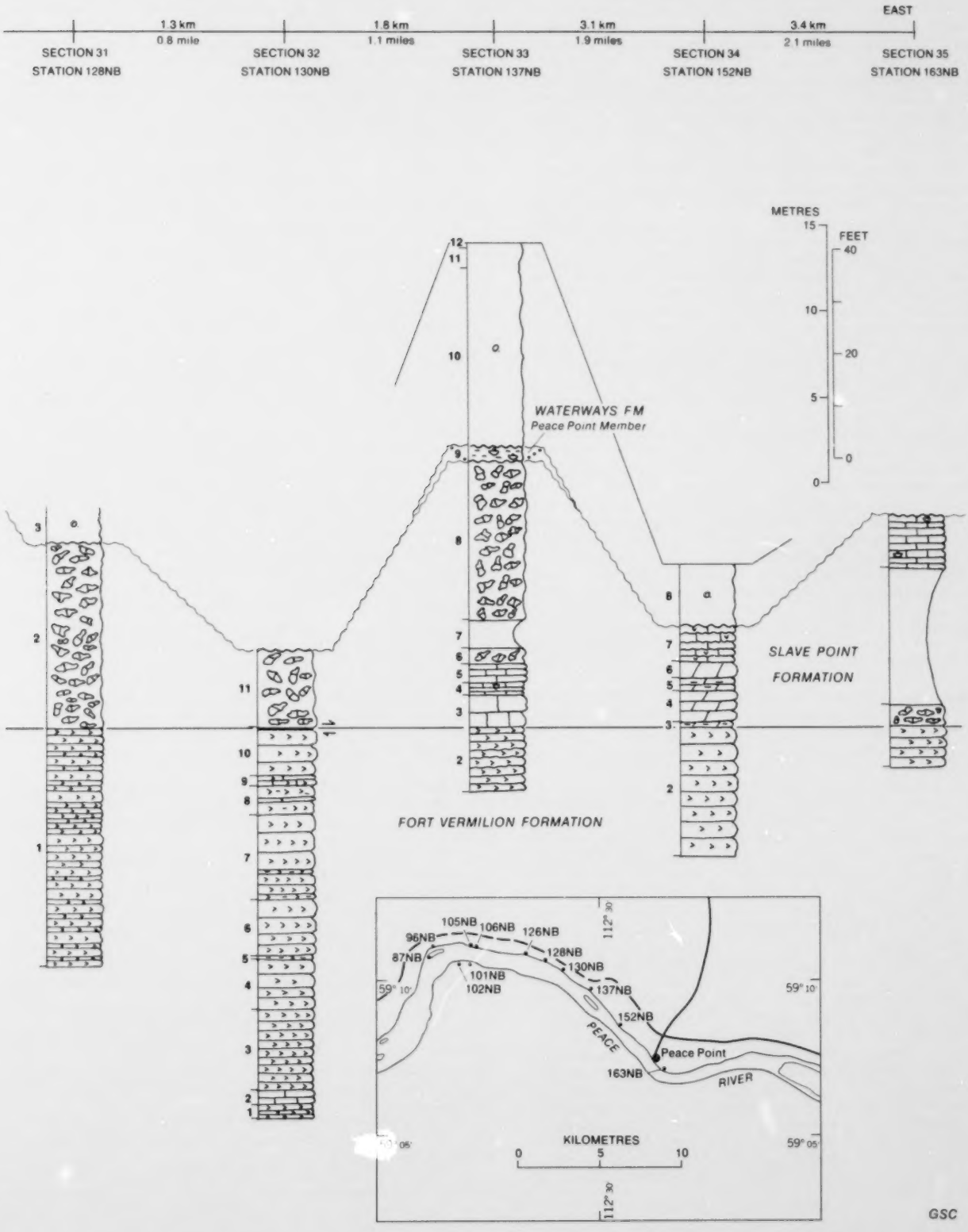


Figure 5. *Diagrammatic representation of selected measured sections of the Fort Vermilion and Slave Point formations and Peace Point Member of the Waterways Formation, Gypsum Cliffs area, Alberta (measured sections from Norris, 1963, p. 124-131).*


EAST
1.3 km
0.8 mile
1.8 km
1.1 miles
3.1 km
1.9 miles
3.4 km
2.1 miles
SECTION 31
STATION 128NB
SECTION 32
STATION 130NB
SECTION 33
STATION 137NB
SECTION 34
STATION 152NB
SECTION 35
STATION 163NB
METRES
FEET
WATERWAYS FM
Peace Point Member
SLAVE POINT
FORMATION
FORT VERMILION FORMATION
105NB
106NB
126NB
96NB
128NB
87NB
130NB
101NB
137NB
102NB
152NB
PEACE
Peace Point
163NB
RIVER
KILOMETRES
0
5
10
112° 30'
59° 10'
59° 05'
GSC

Beds of the Slave Point Formation in the Gypsum Cliffs area are moderately to strongly deformed and commonly brecciated, especially in the western half of the area. The lateral transition from unbrecciated to brecciated sequences is commonly abrupt, and the brecciation varies from all to only parts of the exposed sequence. It appears that most of the brecciation resulted from solution and collapse, but there is also evidence of thin sequences of intercalated sedimentary breccias as well. The brecciated fragments vary greatly in size and are up to 1.5 m in maximum diameter. The randomly oriented larger fragments occur in a matrix of finer fragments of the same material in places showing a vague stratification.

The contact with underlying evaporite beds of the Fort Vermilion Formation is discussed in the section dealing with that formation. The contact with beds of the overlying Peace Point Member of the Waterways Formation is a highly irregular erosional surface and marks a sharp lithological and faunal change. The present upper part of the Slave Point displays a karst topography with sinkholes, widened joint fissures, other irregular cavities, and widespread brecciation resulting from solution of underlying evaporites and collapse of the more resistant capping carbonate beds. Some of the sinkholes and other irregular cavities can be seen in cross section in the steep cliffs along Peace River, especially in the western half of the Gypsum Cliffs area.

The fluctuating and restricted conditions giving rise to the evaporites of the Fort Vermilion Formation were followed by a marked change in environmental conditions. Seawater of normal salinity spread eastward from northeastern British Columbia over areas in which evaporite deposition had previously been dominant. The Slave Point Formation reflects a relatively short period of carbonate sedimentation over a very broad shelf occupying northeastern British Columbia, northern Alberta and the adjacent southern District of Mackenzie (Griffin, 1965a, p. 47).

The fossils and age of the Slave Point Formation are discussed in a succeeding part of this report.

Waterways Formation

Peace Point Member

The name Peace Point beds was proposed by Kindle (1928, p. 16) for the fossiliferous blue shale and thin-bedded limestone overlying limestone and dolomitic limestone referred to the Slave Point Formation by Norris (1963) and underlying Pleistocene and Recent deposits in the Gypsum Cliffs area. The Peace Point beds are clearly equivalent to the basal part of the Waterways Formation which was erected by Warren (1933) and, because of priority, the name was retained and assigned member status by Norris (1963). The type locality of the Waterways Formation is in the Clearwater-Athabasca rivers area of northeastern Alberta where it overlies the Slave Point Formation and underlies the Woodbend Formation of the Woodbend Group. It consists of a sequence of shale and argillaceous limestone alternating with limestone. In the Bear Biltmore No. 1 well (7-11-87-17-W4M), which is the type subsurface section for the five members erected by Crickmay (1957), the formation is 213.8 m thick lying between the depths of 299.0 and 512.8 m. The five members are as follows, in ascending sequence: Firebag, Calumet (Calmut), Christina, Moberly and Mildred.

Beds approximately equivalent to the Waterways Formation in the subsurface of central Alberta were named the Beaverhill Lake Formation by the geological staff of Imperial Oil Limited (1950, p. 1823). This name was applied to the sequence of limestone and shale between the Elk Point and Cooking Lake formations. In the type Anglo-Canadian Beaverhill Lake No. 2 well (11-11-50-17-W4M), the Beaverhill Lake Formation is 220.1 m thick lying between depths of 1318.3 and 1538.3 m.

The Committee on the Slave Point and Beaverhill Lake Formations (Moyer et al., 1964, p. 60) correlated the five members of the Waterways Formation with the upper part of the Beaverhill Lake Formation. They showed also that the thin basal part of the Beaverhill Lake Formation in west-central Alberta contains equivalents of the Slave Point Formation and Fort Vermilion Member.

Fong (1959, p. 97) introduced the term Swan Hills Member of the Beaverhill Lake Formation for a reefal sequence developed in the subsurface of the Swan Hills area of central Alberta. In the type well, the Home Regent "A" Swan Hills 10-10-67-10-W5M, the unit is 101.5 m thick, and occurs in the interval between 2489.3 and 2590.8 m. Leavitt and Fischbuch (1968, p. 290, 291) raised the Swan Hills to formation rank, and grouped it together with the Waterways and Fort Vermilion formations within the Beaverhill Lake, which was raised to group status. Fischbuch (1968) subdivided the Swan Hills Formation into nine informal, laterally persistent units designated, in ascending sequence, as Divisions I to IX. Throughout the Swan Hills area, the Swan Hills Formation overlies evaporites and shales of the Fort Vermilion Formation and is overlain by shales of the Waterways Formation. Fischbuch (1968, p. 452) indicated that the thickness of the Swan Hills Formation varies from a maximum of 152.4 m in the Virginia Hills reef complex to less than 21.3 m north of the House Mountain complex. Fischbuch (1968) concluded on the basis of lithological and faunal evidence that a hiatus separated Divisions V and VI of the Swan Hills Formation and that this hiatus marked the Middle-Upper Devonian boundary.

In a cross section extending from northeastern British Columbia to the Fort McMurray area of northeastern Alberta, Griffin (1965a, Figs. 5 - 7) has traced in the subsurface the equivalents of the five members of the Waterways Formation. The lower two members, Firebag and Calmut (Calumet), are referred to the Lower Beaverhill Lake Formation, and the upper three members, Christina, Moberly and Mildred, are referred to the Upper Beaverhill Lake Formation. The two coarser subdivisions are in places more easily traced in the subsurface than the finer member subdivisions, especially in northwestern Alberta and northeastern British Columbia.

North-northwest of the Athabasca-Clearwater rivers area, the Waterways Formation gradually becomes more shaly and is correlated approximately with the lower half of the lower unnamed shale member of the Hay River Formation as defined by Belyea and McLaren (1962) in the Hay River area of the southern District of Mackenzie. Different correlations of these rock units between the two areas have been presented by Crickmay (1966, p. 13, 14) and Braun (1968, p. 632, Fig. 8) based on brachiopods and ostracodes, respectively.

The depositional edge of the Waterways Formation in the northwest is shown by Bassett and Stout (1968, p. 742, 743, Fig. 10) as a sinuous northeast-trending line extending diagonally across northeastern British Columbia, northwestern Alberta into the southern District of Mackenzie to a position south of the southwest side of Great Slave Lake. This line marks approximately a facies change from platform deposits to the southeast and basinal shales to the northwest (see also Taylor et al., 1975, p. 578, Fig. 1).

Beds of the Peace Point Member of the Waterways Formation were mapped by Norris (1963, Fig. 11) at 14 scattered localities within roughly the western half of the Gypsum Cliffs area. The most easterly exposure occurs on the north bank of Peace River 4.8 km above the ranger cabins at Peace Point.

The maximum thickness of Peace Point beds exposed is about 6.1 m, but most of the exposures show a much thinner sequence (see Fig. 5).

The main lithology is a light to dark olive-green, soft, variably calcareous shale with generally minor intercalated

rubbly thin beds of argillaceous limestone of the same colour containing numerous brachiopods. At one section showing a preponderance of limestone (Station 101NB; Norris, 1963, p. 125, 126), the basal beds (2.2 m exposed) of the Peace Point Member consist of (in ascending sequence): dark brownish grey to black carbonaceous shale interlaminated with argillaceous limestone (0.03 m thick); dark brownish grey, fine-grained, massive limestone weathering medium yellowish brown and containing a sparse fauna (1.2 m thick); light greenish grey, rubbly, thin-bedded limestone separated by olive-green shale partings and containing a sparse fauna (0.6 m thick); and olive-green soft shale with angular fragments and containing an abundant brachiopod fauna (0.3 m exposed).

Iron sulphide partly encrusting and replacing fossils and as small irregular masses is relatively common in the shale. Nodules of native sulphur up to 10.2 cm in diameter and coated with a dark brown weathering rind were also noted in the shale.

The mode of preservation of the Peace Point Member in the Gypsum Cliffs area is within sinkholes, widened joint fissures and other irregular cavities within the Slave Point Formation, indicating that these features formed prior to the deposition of the succeeding beds. The Peace Point beds are commonly brecciated along with the underlying beds, suggesting that they were deposited or slumped into the cavities where they have been protected from removal by erosion. The Peace Point beds are found at various heights above river level and their brecciation along with the underlying beds suggests at least some of the deformation and brecciation in the Gypsum Cliffs area is post-Peace Point in age. On the basis of the sharp lithological change and marked megafaunal break, Norris (1963, p. 65) postulated a depositional hiatus between the Slave Point Formation and Peace Point Member of the Waterways Formation. Evidence from the present study suggests that this hiatus was of relatively short duration because there appear to be no missing conodont zones across the boundary. Beds of the Peace Point Member are unconformably overlain by Pleistocene and Recent deposits in the Gypsum Cliffs area.

The Waterways Formation is interpreted by Jansa and Fischbuch (1974, p. 91) as a basin-filling, open marine transgressive sequence, in which the marine transgression was gradual and associated with a gradual deepening of the basin. The common occurrence of pyrite, especially in the lower shale part of the Waterways Formation, suggests reducing conditions.

BIOSTRATIGRAPHY

Age and correlation of megafaunas

Fort Vermilion Formation

No fossils have been recovered from the gypsum and minor intercalated carbonate beds of the Fort Vermilion Formation in the Gypsum Cliffs area. However, its stratigraphic position above the Watt Mountain Formation and equivalent beds and below the Slave Point Formation suggests that this rock unit occurs at a level above the highest occurrence of *Stringocephalus* in western Canada.

Slave Point Formation

A sparse and poorly preserved megafauna of low diversity has been recovered from the Slave Point Formation in the Gypsum Cliffs area. In the present study, fossils collected from the upper 2.5 m of the Slave Point Formation at Stations 261NB and 262NB of Section 2, where 14.7 m of beds are represented, comprise the following (see Appendix):

bulbous stromatoporoid fragment
Amphipora? sp.
undet. loosely coiled gastropod
Desquamatia (Independatrypa) sp. cf. *D. (I.) independensis* (Webster)
echinoderm ossicle with single axial canal
echinoderm ossicle with double axial canal

Of these, probably the most diagnostic form is *Desquamatia (Independatrypa)* sp. cf. *D. (I.) independensis*, which is described and illustrated in this report. This species occurs typically in the lower part of the Solon Member of the Cedar Valley Formation of Iowa where the containing beds are referred to by Stainbrook (1941, p. 324) as the *independensis* Zone. Associated conodonts in the *independensis* Zone have been referred to the Middle *varcus* Subzone by Ziegler et al. (1976).

In the Devonian outcrop belt of southwestern Manitoba, *Desquamatia (Independatrypa) independensis* and *D. (I.)* sp. cf. *D. (I.) independensis* occur in the Argillaceous limestone beds and *D. (I.)* sp. cf. *D. (I.) independensis* occurs in the Micritic limestone beds of the Point Wilkins Member of the Souris River Formation (Norris et al., in press).

The stromatoporoids in the upper beds of the Slave Point Formation in the Gypsum Cliffs area are represented by only a few stray fragments but are locally exceedingly abundant in the upper part of the Slave Point in the subsurface west of the type area in the southern District of Mackenzie and in northeastern British Columbia (see Belyea and Norris, 1962, p. 14). They are also abundant in the correlative upper reefal beds of the Sulphur Point Formation in the Burnt Point area of Great Slave Lake near the carbonate-shale facies transition.

Of interest in the above list is the presence of a small echinoderm ossicle with a double axial canal that occurs abundantly in Members B and C of the Dawson Bay Formation of the Devonian outcrop belt of southwestern Manitoba associated with conodonts assigned by Uyeno (in Norris et al., in press) to the Middle *varcus* Subzone. This ossicle is much smaller than *Gasterocoma*? *bicaula* Johnson and Lane, which occurs at a much lower stratigraphic level in rocks of mid- to late Emsian and early Eifelian age.

Other fossils collected by Norris (1963, p. 63) in 1956 from the lower 9.1 m or so of the Slave Point Formation at several localities comprise the following:

cf. *Modiolopsis* sp. (of Kindle, 1928)
Gypidula sp.
Atrypa sp.
Spinatrypa sp.
Emanuella sp. cf. *E. meristoides* (Meek)
Emanuella sp. C (=*Emanuella vernilis* Crickmay, 1967)

The most abundant form in this fauna is an elongate pelecypod identified by Kindle (1928, p. 15) as *Modiolopsis* sp. and *Modiolopsis* sp. cf. *orthonota* (Conrad). An associated brachiopod identified as *Spirifer crispus* (Hisinger) by Kindle (1928) was probably a poorly preserved *Emanuella*. It was on the basis of *Spirifer crispus* that Kindle (1928) dated the containing beds as Silurian and correlated them with the "Fitzgerald dolomite" of Cameron (1918) outcropping along Slave River south of Fort Fitzgerald. The latter beds are now known to contain the ostracode *Moelleritia canadensis* Copeland of late Early Devonian age and correlate with the Ernestina Lake Formation of the Lower Elk Point Subgroup in the subsurface of northeastern Alberta and northwestern Saskatchewan.

The form indicated as *Emanuella* sp. C by Norris (1963, p. 63) appears to be equivalent to *Emanuella* sp. S by

Crickmay (1966) which was later formally named *Emanuella vernilis* Crickmay (1967, p. 8, 9, Pl. 2, figs. 13 - 19, Pl. 3, figs. 7 - 9). *Emanuella vernilis* has been recorded by Crickmay (1967) from beds of the Slave Point Formation at Gypsum Cliffs, from the Slave Point Formation at Slave Point, and from beds mapped as Sulphur Point Formation at Burnt Point and Windy Point, all on the northwestern shore of Great Slave Lake in the southern District of Mackenzie. Another closely related but distinct form is *Emanuella* sp. F, which occurs in both the Sulphur Point and Slave Point formations of the Great Slave Lake area (Norris, 1965, p. 72, 78). *Emanuella* sp. F is possibly identical to a form designated as *Emanuella* sp. I by Caldwell (1968, p. 612, Pl. 1, figs. 14a - d) which was recorded from the upper part of the Slave Point Formation at a depth of 1321.9 m in the California Standard Steen River 2-22-117-5-W6M well in northwestern Alberta. Caldwell (1968) indicated that *Emanuella* sp. I ranges down into older Middle Devonian rocks.

Pedder (1972, p. 708) has shown that beds of the Slave Point Formation and some equivalent beds of the Sulphur Point Formation in the southern District of Mackenzie occur within the coral *Grypophyllum mackenziense* Zone, which in turn coincides approximately with the conodont Upper *hermanni-cristatus* Zone. These conclusions were based on material from the Imperial Sun Arrowhead I-46 well (60°45'37"N, 122°22'47"W; 1875.1 - 1963.7 m) and Union Pan Am Trainor L-59 well (60°28'33"N, 120°40'50"W; 1870.5 - 1980 m). Ostracodes within the *Grypophyllum mackenziense* Zone identified by Braun (in Norford et al., 1970) from between 1870.5 and 1980 m in the Imperial Sun Arrowhead I-46 well include *Aparchites diuturnus* (McGill), *Bairdiocypris homolibra* (McGill) and *Microcheillinella* sp. cf. *M. boweni* McGill. These forms, according to Braun, indicate a correlation with the Slave Point Formation and possibly underlying beds of north-central Alberta.

Two species of the tetracoral genus *Temnophyllum*, *T. macconelli* Pedder and *T. lenzi* Pedder, are common associates in the *Grypophyllum mackenziense* Zone (Pedder, 1972, 1973). The *G. mackenziense* Zone has been reported by Pedder (1973, p. 108) from the upper part of the Ramparts Formation of the Norman Wells area, from the upper Sulphur Point Formation outcropping in the Burnt Point area on the northwest side of Great Slave Lake and in the subsurface of the southern District of Mackenzie and northwestern Alberta, and from the platform beds of the Swan Hills Formation in the subsurface of central Alberta.

Fischbuch (1968), in his detailed study of the Swan Hills Formation, has indicated that Divisions I to V inclusive of this formation contain a typical Middle Devonian microfauna that indicates correlation with at least part of the Slave Point Formation. In addition, he (ibid., Figs. 36, 37) has shown the distribution and ranges of the various stromatoporoids in the Swan Hills Formation along with some of the associated ostracodes.

Crickmay (1967, p. 9, Pl. 2, figs. 25 - 29, Pl. 3, figs. 10 - 15) described the ambocoeliid brachiopod, *Ladjia landesi*, from the lower part of the Swan Hills Formation penetrated by the KCL-Midwest Otter Lake No. 10-10 well at a depth of 1600.1 m.

McGill (1966) studied the ostracodes of the Slave Point Formation from two wells, Homestead et al. Joussard 10-32-72-13-W5M and Guyer Imperial Driftpile 4-7-73-11-W5M, south and southwest of Lesser Slave Lake in central Alberta. He concluded that they may be latest Givetian in age and that the Givetian-Frasnian boundary occurs at the contact between the Slave Point and overlying Beaverhill Lake (Waterways) Formation.

In conclusion, the Slave Point Formation of the Gypsum Cliffs area occurs in a post-*Stringocephalus* stratigraphic position and contains a sparse and poorly preserved megafauna. Its two most diagnostic elements comprise *Emanuella vernilis* Crickmay from the lower part and *Desquamatia (Independatrypa)* sp. cf. *D. (I.) independensis* (Webster) from the upper part of the formation. These forms were considered by Crickmay (1966) as zonal indices of the *vernilis* and *independensis* zones, respectively. *Emanuella vernilis* occurs also in the upper part of the Sulphur Point Formation outcropping in the Burnt Point area on the northwest side of Great Slave Lake where it is associated with the tetracoral *Grypophyllum mackenziense* (Pedder). The range of the latter form where firmly dated by associated conodonts appears to be restricted to the Upper *hermanni-cristatus* Zone, and is formally recognized by Pedder (1972, 1973) as a coral zone. *Desquamatia (Independatrypa)* sp. cf. *D. (I.) independensis* (Webster) has a longer range and therefore is of less correlative value. In southwestern Manitoba, this form ranges from the Argillaceous limestone beds to the Micritic limestone beds of the Point Wilkins Member of the Souris River Formation where associated conodonts are assigned by Uyeno (in Norris et al., in press) to the Upper *varcus* Subzone and/or *hermanni-cristatus* Zone and *insita* fauna, respectively.

Waterways Formation

Peace Point Member

A rich brachiopod fauna occurs in beds of the Peace Point Member of the Waterways Formation found at scattered localities in the western part of the Gypsum Cliffs area. Brachiopod fossils collected from these beds in 1977 that are described and illustrated in this report comprise the following (see Fig. 6 for distribution and relative abundance):

Schizophoria lata Stainbrook
Schizophoria sp. cf. *S. allani* Warren
Strophodonta sp.
Ladogioides pax McLaren
Platyterorhynchus russelli (McLaren)
Platyterorhynchus russelli (McLaren) Form A, new
Desquamatia (Independatrypa) independensis (Webster)
Desquamatia (Variatrypa) clarkei (Warren)
Desquamatia (Variatrypa) klukasi n. sp.
Pseudoatrypa devoniana boyeri n. ssp.
Pseudogruenewaldtia? sp.
Tecnocyrtina billingsi (Meek)
Eleutherokomma impennis Crickmay

Other fossils present in these beds, but not described in this report, comprise the following: rare small bulbous stromatoporoids present in some of the intercalated limestone beds; *Aulopora* sp. and *Spirorbis* sp., both commonly encrusting brachiopods; two or three species of pelecypods; a gastropod species; and an echinoderm ossicle with a single axial canal occurring as scattered fragments in some of the limestone beds. A thin, broad, coarsely costate *Spinatrypa* is also known as a rare element of this fauna. It was referred to as *Spinatrypa albertensis* (Warren) var. (Norris, 1963, p. 65).

The most diagnostic fossils in the above list appear to be *Ladogioides pax* McLaren, *Platyterorhynchus russelli* (McLaren), *Tecnocyrtina billingsi* (Meek) and *Eleutherokomma impennis* Crickmay. All of these fossils are known also from the Firebag Member of the Waterways Formation outcropping at scattered localities along the Clearwater and Athabasca rivers in northeastern Alberta. In previous lists by Norris (1963, Figs. 6, 8), these were recorded as *Ladogia kakwaensis* McLaren, *?Ladogia* sp. B, *Cyrtina billingsi* Meek and *Eleutherokomma impennis* Crickmay, respectively. Other species common to both members, particularly amongst the schizophoriids and

atrypids, will no doubt become apparent when the brachiopod fauna of the Firebag Member is more throughly studied at a later date.

Ladogioides pax and *Platyterorhynchus russelli* have a restricted range within the Firebag Member and equivalent beds. *Tecnocyrtina billingsi* ranges through the Firebag, Calumet, and Christina members into the lower part of the Moberly Member; and *Eleutherokomma impennis* ranges through the Firebag and Calumet members and into the Christina member of the Waterways Formation of northeastern Alberta.

Three of the four diagnostic species indicated above have previously been proposed as zonal indices. *Ladogioides pax* McLaren and *L. kakwaensis* (McLaren), although occurring in different areas, were proposed by McLaren (1962, p. 15) as the basal Upper Devonian rhynchonelloid zone in western Canada. Their combined stratigraphic range is approximately equivalent to Crickmay's (1966) *Eleutherokomma impennis, Strophodonta costata* and *Eleutherokomma jasperensis* zones. *Tecnocyrtina billingsi* (Meek) was proposed by Pedder (in Lenz and Pedder, 1972, p. 37; Pedder, 1975, p. 574, 575) as a zonal index because of its wide geographic distribution and relative ease of identification. In the lower Mackenzie Valley, the fauna characterized by the name bearer occurs in the unnamed Allochthonous beds exposed on Powell Creek (65°16'30"N, 128°46'00"W). A somewhat similar faunal assemblage with *Tecnocyrtina* from central Nevada has been referred to by Johnson (1978) as the *Tecnocyrtina* fauna. *Eleutherokomma impennis* Crickmay was proposed as a zonal index by Crickmay (1966) for the megafauna occurring above the *Desquamatia (Independatrypa) independensis* Zone and below the megafauna of the *Strophodonta costata* Zone. The *impennis* Zone was recorded by Crickmay (1966) in the lower Firebag and Peace Point members of the Waterways Formation of northern Alberta, and in the basal Hay River Formation of the southern District of Mackenzie. Fossils indicative of the zone including *Eleutherokomma* sp. cf. *E. impennis* Crickmay and *Ladogioides pax* McLaren have been recorded by Norris (in Thorsteinsson and Tozer, 1962, p. 59) and by Harrington (1971) from near the base of the Weatherall Formation, on northeastern Banks Island, in the Canadian Arctic.

Age and correlation of conodont faunas

Slave Point Formation

The Slave Point Formation yielded a conodont fauna of low diversity, consisting of *Polygnathus brevilaminus* Branson and Mehl, *Icriodus subterminus* Youngquist, and possibly *Ozarkodina semialternans* (Wirth). The first two species are relatively long ranging, and occur through most of the Waterways Formation in northeastern and central Alberta (Uyeno, 1974, Table 1). In southern Manitoba, they were recovered from the "First Red" and Argillaceous limestone beds of the Point Wilkins Member of the Souris River Formation, with the latter unit also carrying, among other species, *Mehlina gradata* Youngquist, *Ozarkodina brevis* (Bischoff and Ziegler), *O. semialternans* (Wirth), and *Polygnathus xylus xylus* Stauffer. *Ozarkodina semialternans* extends upward into the Micritic limestone beds of the Point Wilkins Member. With the exception of a single specimen in the upper part of Member D of the Dawson Bay Formation, *Icriodus subterminus* is restricted to the Souris River Formation in southern Manitoba. The conodonts from the lower part of the Point Wilkins Member were tentatively assigned to the Upper *varcus* Subzone of Ziegler et al. (1976) and/or the *hermanni-cristatus* Zone (Uyeno, in Norris et al., in press), and may possibly be assignable to the Lowermost *asymmetricus* Zone as well. From the Grand Canyon area, Arizona, D. Schumacher (pers. com., Sept. 24, 1978) has found a similar sparse conodont fauna consisting of *Polygnathus brevilaminus* Branson and Mehl and *Icriodus subterminus* Youngquist in the basal Temple Butte Formation some 6.1 - 9.1 m below the first *Pandorinellina insita* (Stauffer) in strata he assigned to the *hermanni-cristatus* Zone.

The Slave Point conodont fauna belongs to the polygnathid-icriodid biofacies, similar to that proposed by Sandberg (1976), which probably was deposited in shallow water near a cratonic edge. As indicated above, it cannot be precisely dated but, based on other criteria, such as the conodont fauna of the overlying Peace Point Member of the Waterways Formation, as well as those outlined elsewhere, it probably represents a biofacies of the *hermanni-cristatus* Zone. This is in accordance with the finding of Schumacher (1976) who noted that, in the *hermanni-cristatus* Zone of the Cedar Valley Formation of Missouri, the genus *Schmidtognathus* is restricted to a deep subtidal depositional environment, whereas only the icriodids and polygnathids occur in a shallow subtidal environment.

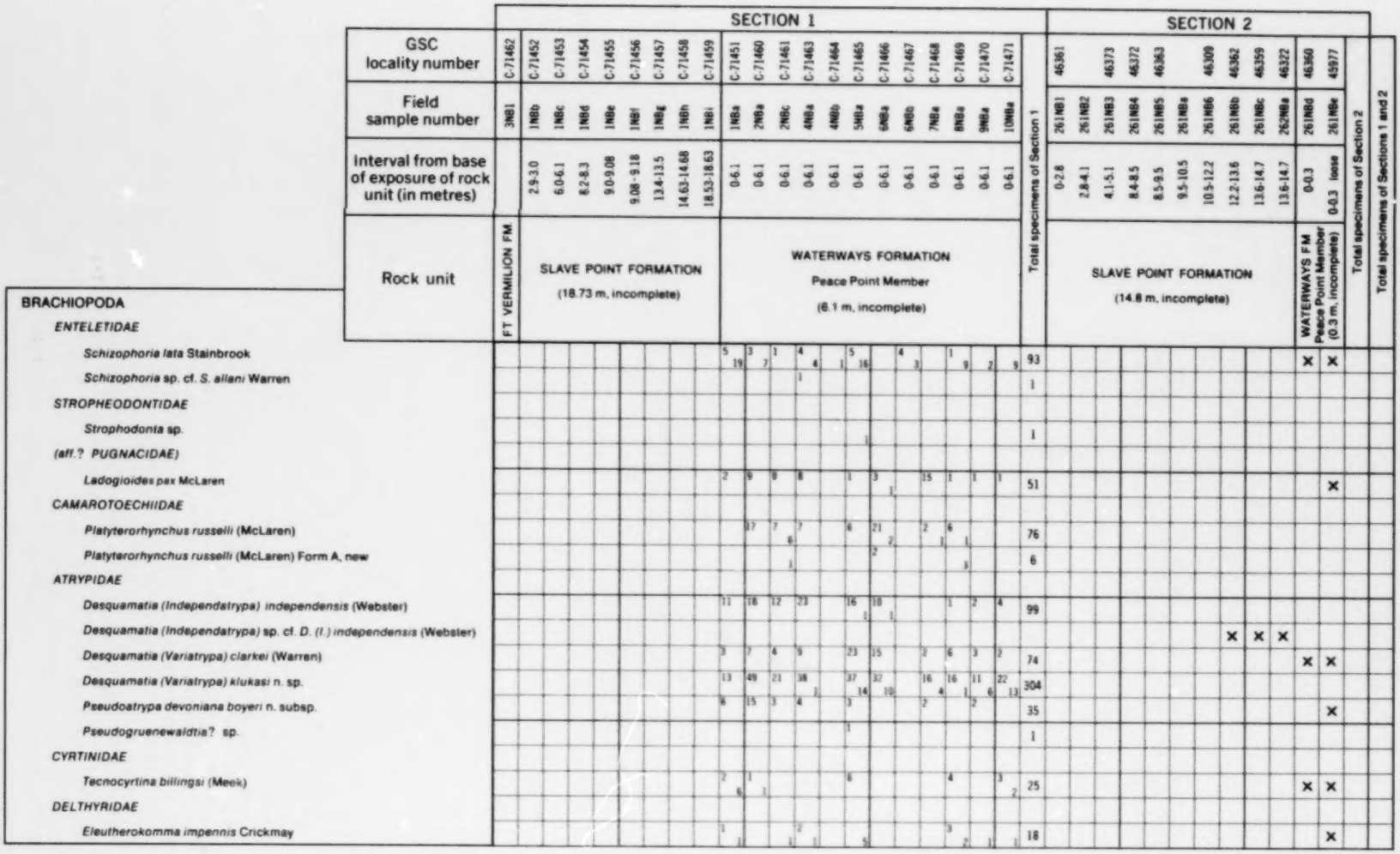
Waterways Formation

Peace Point Member

The conodont fauna of the Peace Point Member of the Waterways Formation is more diverse than that of the underlying Slave Point Formation. It consists of *Pandorinellina insita* (Stauffer), *P.* cf. *P. insita* (Stauffer), *Polygnathus* cf. *P. dubius* Hinde, *P.* cf. *P. pennatus* Hinde, *P. webbi* Stauffer, *Icriodus subterminus* Youngquist, and *I.* cf. *I. subterminus* Youngquist, with the first-mentioned being the characteristic consituent. The form identified as *Pandorinellina* cf. *P. insita* is identical to that found in the Firebag Member of the Waterways in the subsurface of northeastern Alberta (Uyeno, 1974, Tables 1, 4(b)), and has been reported also from the "niveau des monstres" in the lower part of the "Frasnes" Group in the subsurface at Doische and at Sourd d'Ave in the Franco-Belgian Ardennes (Bultynck, 1975, p. 17, 25, Figs. 3, 4). The form has been regarded as morphologically transitional between *Pandorinellina insita* and *Ancyrodella rotundiloba binodosa* Uyeno (Uyeno, 1967, p. 11; 1974, p. 44; Klapper et al., 1970, p. 300, 301; Bultynck, 1975, p. 17, 25). At the Sourd d'Ave locality, it occurs as low as the Upper Member of the Fromelennes Formation of the Calcaire de Givet. The range in the Ardennes is from the Middle-Upper Devonian boundary beds (*hermanni-cristatus* - Lowermost *asymmetricus* zones) to Lower *asymmetricus* Zone.

Polygnathus webbi ranges almost throughout the Waterways Formation, but the Peace Point form is morphologically closest to that from the Firebag Member (Uyeno, 1974, Pl. 5, fig. 7). Some Peace Point specimens are only somewhat similar to *Polygnathus pennatus* and *P. dubius*, so a detailed discussion on their biostratigraphic significance is not warranted, but these species have been recorded from the Upper *hermanni-cristatus* Zone to Lower *asymmetricus* Zone (Klapper in Ziegler, 1973, p. 354, 373). The latter form has been recovered also from the Micritic limestone beds, Point Wilkins Member, Souris River Formation of southern Manitoba. The range of *Icriodus subterminus* has been discussed earlier under Slave Point conodonts.

The Peace Point conodonts belong to the *insita* fauna, as defined by Klapper et al. (1970, p. 300), and to the shallow-water *insita* biofacies, as proposed by Sandberg and Poole (1977, p. 150). The age of these conodonts is not


SECTION 1
SECTION 2
GSC locality number
Field sample number
Interval from base of exposure of rock unit (in metres)
Rock unit
FT VERMILION FM
SLAVE POINT FORMATION (18.73 m, incomplete)
WATERWAYS FORMATION Peace Point Member (6.1 m, incomplete)
Total specimens of Section 1
SLAVE POINT FORMATION (14.8 m, incomplete)
WATERWAYS FM Peace Point Member (0.3 m, incomplete)
Total specimens of Section 2
Total specimens of Sections 1 and 2
BRACHIOPODA
ENTELETIDAE
Schizophoria lata Stainbrook
Schizophoria sp. cf. S. allani Warren
STROPHEODONTIDAE
Strophodonta sp.
(aff.? PUGNACIDAE)
Ladogioides pax McLaren
CAMAROTOECHIIDAE
Platyterorhynchus russelli (McLaren)
Platyterorhynchus russelli (McLaren) Form A, new
ATRYPIDAE
Desquamatia (Independatrypa) independensis (Webster)
Desquamatia (Independatrypa) sp. cf. D. (I.) independensis (Webster)
Desquamatia (Variatrypa) clarkei (Warren)
Desquamatia (Variatrypa) klukasi n. sp.
Pseudoatrypa devoniana boyeri n. subsp.
Pseudogruenewaldtia? sp.
CYRTINIDAE
Tecnocyrtina billingsi (Meek)
DELTHYRIDAE
Eleutherokomma impennis Crickmay

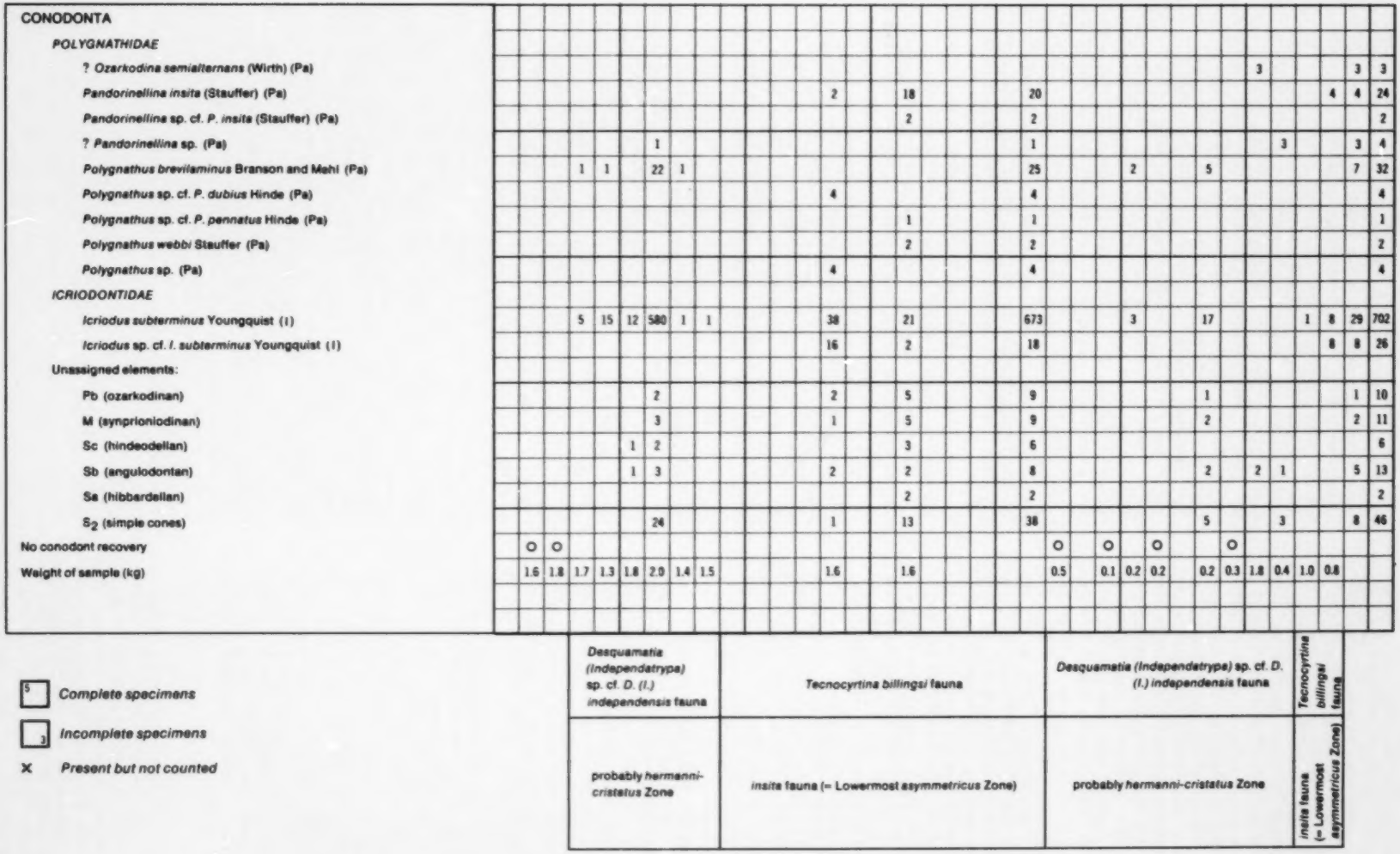

CONODONTA
POLYGNATHIDAE
? Ozarkodina semialternans (Wirth) (Pa)
Pandorinellina insita (Stauffer) (Pa)
Pandorinellina sp. cf. P. insita (Stauffer) (Pa)
? Pandorinellina sp. (Pa)
Polygnathus brevilaminus Branson and Mehl (Pa)
Polygnathus sp. cf. P. dubius Hinde (Pa)
Polygnathus sp. cf. P. pennatus Hinde (Pa)
Polygnathus webbi Stauffer (Pa)
Polygnathus sp. (Pa)
ICRIODONTIDAE
Icriodus subterminus Youngquist (I)
Icriodus sp. cf. I. subterminus Youngquist (I)
Unassigned elements:
Pb (ozarkodinan)
M (synprioniodinan)
Sc (hindeodellan)
Sb (angulodontan)
Sa (hibbardellan)
S2 (simple cones)
No conodont recovery
Weight of sample (kg)
1.6 1.8 1.7 1.3 1.8 2.0 1.4 1.5 1.6 1.6 0.5 0.1 0.2 0.2 0.2 0.3 1.8 0.4 1.0 0.8
Complete specimens
Incomplete specimens
Present but not counted
Desquamatia (Independatrypa) sp. cf. D. (I.) independensis fauna
Tecnocyrtina billingsi fauna
Desquamatia (Independatrypa) sp. cf. D. (I.) independensis fauna
Tecnocyrtina billingsi fauna
probably hermanni-cristatus Zone
insita fauna (= Lowermost asymmetricus Zone)
probably hermanni-cristatus Zone
insita fauna (= Lowermost asymmetricus Zone)

Figure 6. *Chart showing distribution of brachiopods and conodonts in rocks of Sections 1 and 2.*

decisive, with a relatively broad range of *Upper *hermanni-cristatus* Zone to Lower *asymmetricus* Zone. Based on the close similarity between this and Firebag fauna, however, the Peace Point conodonts are probably assignable to the Lowermost *asymmetricus* Zone. In terms of the southern Manitoba sequence, the Peace Point conodonts are closest to those of the Micritic limestone beds of the Point Wilkins Member of the Souris River Formation (Uyeno, in Norris et al., in press).

It should be noted here, as has been done elsewhere, that at least the higher beds containing conodonts of the *insita* fauna invariably have been found to contain also megafaunas regarded to be of Upper Devonian affinity. The strata concerned include the Firebag and the lower part of the Calumet Member of the Waterways Formation, of northeastern and central Alberta (Klapper et al., 1970, p. 300; Uyeno, 1974, p. 18); the Allochthonous beds of Powell Creek, western District of Mackenzie (of MacKenzie, 1971; = "Unnamed beds" of Braun, 1966) (Uyeno, 1978); the State Quarry Limestone of Iowa (Klapper, 1968, p. 12); the Micritic limestone beds of the Point Wilkins Member, and the Sagemace Member, Souris River Formation of southern Manitoba (Norris et al., in press); the Starbird Formation in southeastern British Columbia (undescribed collection; McLaren, 1962, p. 3); and Devils Gate Limestone in central Nevada (Johnson, 1978). The upper part of the Callaway Formation of Missouri and Coralville Member, Cedar Valley Limestone, of Iowa also carry the *insita* fauna, but the associated megafauna are yet to be studied in detail (Klapper et al., 1970, p. 300). As mentioned previously, the *insita* fauna is present also in the lower Temple Butte Formation, Grand Canyon, Arizona (unpubl. data, D. Schumacher, pers. com., Sept 24, 1978).

Summary statement

The rich fauna derived from the basal 6.1 m of the Peace Point Member of the Waterways Formation at Gypsum Cliffs represents a single faunal assemblage. The abrupt appearance of genera and species not found in underlying beds at Gypsum Cliffs and elsewhere prompted Norris (1963, p. 65) and others to postulate a hiatus separating the Waterways Formation from the underlying Slave Point Formation in northern Alberta. This faunal break may be that recognized as follows: by Fischbuch (1968) between Divisions VI and V of the reefal Swan Hills Formation of central Alberta based on a study of the stromatoporoids; between the Waterways (Beaverhill Lake) Formation and the Slave Point Formation based on ostracodes studied by McGill (1963, 1966) and by Braun (1968, 1977); between the Micritic limestone beds and the Argillaceous limestone beds of the Point Wilkins Member of the Souris River Formation of southwestern Manitoba based on brachiopods and conodonts (Norris et al., in press); between the Hay River Formation and the Slave Point Formation of the southern District of Mackenzie based on brachiopods (Norris, 1965; McLaren in Belyea and McLaren, 1962); between the unnamed Allochthonous beds and the Ramparts Formation on Powell Creek, lower Mackenzie Valley, documented by Pedder (1975) and Uyeno (1978); and between the Canol Formation and various underlying formations in the northern Yukon Territory described by Norris (1968).

At Gypsum Cliffs the faunal break is between the Peace Point Member of the Waterways Formation and the Slave Point Formation. The former is characterized by *Ladogioides pax*, *Platyterorhynchus russelli*, *Tecnocyrtina billingsi* and *Eleutherokomma impennis*, associated with a conodont assemblage representative of the *Pandorinellina insita* fauna. The Slave Point contains a sparse brachiopod fauna characterized by *Desquamatia (Independatrypa)* sp. cf. *D. (I.) independensis* associated with the conodonts *Polygnathus brevilaminus* and *Icriodus subterminus* in the upper part, and *Emanuella vernilis* in the lower part. The *Pandorinellina insita* fauna at Gypsum Cliffs, by comparison with the conodont sequence established by Uyeno (1974, Table 2) in northeastern and central Alberta and the conodont sequence for western United States (Sandberg and Poole, 1977, Fig. 2), probably corresponds to a level within the Lowermost *Polygnathus asymmetricus* Zone. The conodonts *Polygnathus brevilaminus* Branson and Mehl and *Icriodus subterminus* Youngquist, present in the upper Slave Point, by comparison with the conodont sequence established by Uyeno (in Norris et al., in press) for southwestern Manitoba, suggests assignment to the Upper *varcus* Subzone and/or *hermanni-cristatus* Zone. Uyeno currently interprets these conodonts as a shallow-water fauna, perhaps a restricted biofacies of the *hermanni- cristatus* Zone.

The Middle-Upper Devonian boundary is unresolved with several alternative levels under study by the Subcommission on Devonian Stratigraphy of the International Commission on Stratigraphy. House and Ziegler (1977) discussed in detail the advantages and disadvantages of three main fossil zones among others that could be used to distinguish the Middle-Upper Devonian boundary, and these levels comprise (i) base of the ammonoid *lunulicosta* Zone (1∝) which is approximately alinged with the upper part of the conodont *varcus* Zone; (ii) base of the conodont *hermanni-cristatus* Zone; and (iii) base of the conodont Lower *asymmetricus* Zone. Levels 1 and 2 are poorly represented in Canada. The Middle-Upper Devonian boundary currently preferred in western Canada, and represented at Gypsum Cliffs, does not correspond to any of the levels indicated above, but is between levels 3 and 2. It is indicated on the accompanying Table 1 as level 4.

In terms of conodont zonation (see Sandberg et al., 1975), the base of the Lower *Polygnathus asymmetricus* Zone (level 3 on Table 1) would correspond to the base of the Frasnian if the boundary in the stratotypes between the Givetian (Middle Devonian) and Frasnian (Upper Devonian) stages in northern France and southern Belgium was raised to the boundary between the Assise de Fromelennes and the "Monstres" bed as favoured by some Belgian geologists (e.g. Errera et al., 1972) and shown by Tsien (1972, Table 2). In northern Alberta, the base of the Lower *Polygnathus asymmetricus* Zone is placed by Uyeno (1974, Table 1) within the lower part of the Calumet (Calmut) Member of the Waterways Formation. The conodonts below the base of the Lower *asymmetricus* Zone, in the lower part of the Calumet and Firebag members of the Waterways Formation, are assigned to the *Pandorinellina insita* fauna by Uyeno (1974, Table 2), which probably corresponds to the Lowermost *Polygnathus asymmetricus* Zone of the standard conodont zonation (see Sandberg and Poole, 1977, Fig. 2). This interval correlates to a position high in the Formation de Fromelennes of the Groupe de Givet in the Franco-Belgian Ardennes,

*Recently, Johnson, Klapper and Trojan (1980, p. 97) pointed out that the evidence for the oldest part of the *insita* biofacies being a lateral facies equivalent of the Upper *hermanni - cristatus* Zone is not compelling. They suggest that the oldest part of the *insita* biofacies more probably represents equivalents of the *dengleri* Zone. More recently, Ziegler and Klapper (1981 MS) recommended that the interval between the Upper *hermanni - cristatus* Zone and the Lowermost *asymmetricus* Zone characterized by the first appearance of *Palmatolepis disparilis* be named the *disparilis* Zone, and the name *dengleri* Zone be discontinued.

Table 1. *Conodont and brachiopod faunas represented at Gypsum Cliffs and possible conodont correlatives*[1]*. Levels 1 to 4 mentioned in text could be used to mark the Middle-Upper Devonian boundary.*

STANDARD CONODONT ZONES			LEVELS	GYPSUM CLIFFS		
				Rock Units	Conodonts	Brachiopods
Polygnathus asymmetricus	Upper		3	WATERWAYS FORMATION		
	Middle					
	Lower					
Lowermost				Peace Point Mbr.	*Pandorinellina insita* fauna	*Tecnocyrtina billingsi* fauna
Schmidtognathus hermanni-Polygnathus cristatus			4	SLAVE POINT FORMATION	Sparse fauna suggestive of *hermanni-cristatus* Zone	*Desquamatia (Independatrypa)* sp. cf. *D. (I.) independensis* *Emanuella vernilis*
Polygnathus vercus	Subzones	Upper	2	FORT VERMILION FORMATION	Unfossiliferous	(post-*Stringocephalus* stratigraphic position)
		Middle	1?		?	
		Lower				

GSC

[1]Since this report was prepared, recent changes in the conodont zonal scheme affecting the Slave Point Formation at Gypsum Cliffs and the upper part of the Ramparts Formation at Powell Creek were discussed by Norris and Uyeno (1981, p. 9, Table 2). The latter beds containing *Grypophyllum mackenziense* and *Leiorhynchus hippocastanea are* associated with conodonts that were assigned by Klapper and Johnson (1980) to the Lower *Polygnathus dengleri* Subzone. By inference, Norris and Uyeno (1981) questionably assigned the Slave Point beds at Gypsum Cliffs to this same conodont subzone. However, at a meeting of the Subcommission on Devonian Stratigraphy held at Binghamton, New York, 21 - 22 July 1981, Ziegler and Klapper (1981 MS) indicated that the *Polygnathus dengleri* Zone be considered obsolete. In their revised zonal scheme the upper Ramparts beds at Powell Creek would now be assigned to a newly named *Palmatolepis disparilis* Zone. This new zone occupies an interval above the Upper *hermanni-cristatus* Zone and below the Lowermost *asymmetricus* Zone. The Slave Point beds at Gypsum Cliffs, although containing a restricted conodont fauna, would questionably be assigned to the newly named *disparilis* Zone.

because it occurs below the first occurrence of *Ancyrodella rotundiloba binodosa* Uyeno. Thus, the fauna of the Peace Point Member at Gypsum Cliffs, which correlates with the basal Firebag member of northeastern Alberta, based on brachiopods, conodonts and stratigraphic position, probably corresponds to the Lowermost *Polygnathus asymmetricus* Zone. It is the base of this interval, marked by the Lowermost *P. asymmetricus* Zone, that most Devonian workers in western Canada have tentatively and traditionally selected as the base of the Upper Devonian*. The base of the Lowermost *P. asymmetricus* Zone in northern Alberta closely coincides with the appearance of numerous brachiopods including *Ladogioides pax, Platyterorhynchus russelli, Tecnocyrtina billingsi* and *Eleutherokomma impennis* of Upper Devonian affinity. This distinctive brachiopod fauna is here referred to as the *Tecnocyrtina billingsi* fauna.

SYSTEMATIC PALEONTOLOGY

Brachiopoda

Superfamily Enteletacea Waagen, 1884

Family Enteletidae Waagen, 1884

Subfamily Schizophoriinae Schuchert and LeVene, 1929

Genus *Schizophoria* King, 1850

Type species. *Conchyliolithus (Anomites) resupinatus* Martin, 1809, Pl. 49, figs. 13, 14

Schizophoria lata Stainbrook

Plate 2, figures 1 - 22

1940 *Schizophoria lata* Stainbrook, p. 488, Pl. 2, figs. 1 - 7, 15, 16.
1944 *Schizophoria lata* Stainbrook; Warren, p. 109, Pl. 1, fig. 1.
1956 *Schizophoria* sp., Warren and Stelck, Pl. 10, figs. 14 - 16.
1956 *Schizophoria lata* Stainbrook; Warren and Stelck, Pl. 11, figs. 8 - 10.

Material. This form is represented by 23 complete specimens and 69 separated valves and fragments.

Dimensions (mm)

Specimen	A	B	C	D
GSC No.	57009	57010	57011	57012
GSC locality	C-71460	C-71469	C-71460	C-71465
Length of pv	23.6	22.7	29.9	24.8
Length of bv	23.0	22.4	29.3	24.1
Width	27.8	27.9	34.5	30.0
Depth of shell	15.6	13.9	14.7	18.1
Width of interarea	10.1	13.3	15.5	18.5
Depth of sulcus at anterior margin	5.7	4.7	5.7	3.1

*The Middle-Upper Devonian boundary is still (July 29, 1981) unresolved internationally. However, at the last meeting of the Subcommission on Devonian Stratigraphy held at Binghamton, New York, on July 21 - 22, 1981, a small majority of members in a vote favored the first appearance of *Ancyrodella rotundiloba rotundiloba* to mark the base of the Lower *asymmetricus* Zone and base of the Upper Devonian (level 3 on Table 1).

Specimen	E	F	G	H
GSC No.	57013	57014	57015	57016
GSC locality	C-71469	C-71460	C-71465	C-71460
Length of pv	16.5	-	-	30.2
Length of bv	-	-	-	-
Width	17.8	-	-	33.4
Depth of shell	-	-	-	-
Width of interarea	-	-	-	-
Depth of sulcus at anterior margin	-	-	-	-

Specimen	I	J	K
GSC No.	57017	57018	57018a
GSC locality	C-71464	C-71460	C-71469
Length of pv	-	-	-
Length of bv	-	-	-
Width	-	-	-
Depth of shell	-	-	-
Width of interarea	-	-	-
Depth of sulcus at anterior margin	-	-	-

Description. Shell of medium to large size, unequally biconvex, transversely subelliptical in outline, rounded posterolateral and anterolateral margins, wider than long, widest at about midlength, weak uniplicate anterior margin.

Pedicle valve very gently convex, highest at about one-quarter to one-third length from beak, highly convex toward cardinal margin, flanks very gently convex to flat and in some specimens slightly concave toward anterolateral margins. A medial sinus originates anterior of midlength which widens and deepens anteriorly to become conspicuous near the anterior margin where it is slightly extended to form a low, broadly U-shaped tongue. Beak large, pointed, incurved toward opposite valve, elevated, extended slightly beyond that of opposite valve. Interarea high, broadly triangular, generally sharp-edged laterally, apsacline throughout most of height, becoming orthocline and slightly anacline near apex. Delthyrium open, narrowly triangular, enclosing an angle of about 48 degrees.

Brachial valve much more convex than the pedicle valve, accounting for two thirds or more total thickness of shell, highest at or slightly posterior to midlength, broadly rounded over umbo, sharply concave toward cardinal and posterolateral margins, flanks steeply sloping and gently convex, slightly rounded medially but no distinct fold. Beak blunt, variably incurved. Dorsal interarea very low, broad, orthocline toward hinge line, becoming strongly apsacline toward apex.

Interior of pedicle valve with deep delthyrial cavity; teeth strong; dental plates prominent, extended anteriorly along sides of muscle area as a variably developed ridge; muscle area bilobate; diductor scars long, divergent, separated by a relatively broad, rounded ridge, marking site of attachment of adductor muscles, which originates a short distance forward of the apex and increases in strength anteriorly. A faint median ridge is present in some specimens anterior of muscle attachment area. In some gerontic specimens, the anterior bounding ridge of muscle area is slightly raised obliquely above the valve floor. In other gerontic specimens, median ridge of muscle area is considerably thickened and terminates anteriorly in a rounded knob. Interior lateral margins of some gerontic specimens display transverse markings and, in some specimens, these areas are sharply elevated above the valve floor to form a distinct rim.

Interior of brachial valve with small trilobate cardinal process having a central median ridge extending a short distance into the notothyrial cavity and with branching, smaller, shorter laterally directed ridges. Crural plates stout, curved, obliquely divergent, enclosing a deep notothyrial cavity. Dental sockets deep, widening anterolaterally. Muscle area quadripartite, the anterior pair of diductors separated from the posterior pair by oblique ridges extending anterolaterally from a median ridge which tapers and terminates a short distance anterior of the medianly indented muscle scar; peripheral edges of muscle scar slightly elevated. Four evenly parallel sinuses can be seen in one specimen originating at anterior edge of muscle scar and extending anteriorly.

Surface of both valves marked by very fine radiating costellae which increase in number anteriorly by bifurcation and implantation, separated by troughs of equal or less width than costellae. A very slight development of parvicostellation on some specimens. Concentric growth lines occur at irregular intervals but are more common toward the anterior and lateral margins. Very fine, closely spaced punctae most evident on abraded parts of shell particularly on crests of costellae. Closely spaced fine lines are evident on both interareas parallel to the hinge line.

Discussion. From *Schizophoria athabaskensis* Warren (1944, p. 110, Pl. 1, figs. 2, 3; Warren and Stelck, 1956, Pl. 11, figs. 11 - 13), *S. lata* differs primarily in being smaller, proportionately thinner, having a flatter, less convex pedicle valve, and a less sinuate anterior margin.

From *Schizophoria allani* Warren (1944, p. 109, Pl. 1, figs. 4, 5; Warren and Stelck, 1956, Pl. 11, figs. 1 - 3), *S. lata* differs in being proportionately thinner, in having a transversely elliptical rather than an elongate oval outline, in having a low, broad U-shaped rather than a pronounced narrow V-shaped pedicle sulcus.

Another form that is somewhat similar to *Schizophoria lata* is *Schizophoria iowensis* (Hall) as described and illustrated by Stainbrook (1940, p. 483 - 486, Pl. 1, figs. 1 - 10) from the *bellula* Zone in the lower part of the Rapid Member of the Cedar Valley Formation of Iowa. *Schizophoria lata* from the Peace Point Member differs in having a smaller, less elongated pedicle beak and by a much flatter, less convex pedicle valve.

Occurrence. *Schizophoria lata* Stainbrook occurs typically in the *waterlooensis* Zone of the upper part of the Rapid Member of the Cedar Valley Formation of Iowa. *Schizophoria lata* is fairly abundant in beds of the Peace Point Member of the Waterways Formation, western part of the Gypsum Cliffs area, Peace River, Alberta.

Judging from faunal lists, descriptions and illustrations (Warren, 1944; Warren and Stelck, 1956; Crickmay, 1966), *S. lata* appears to range throughout the Waterways Formation of northern Alberta.

Figured specimens. GSC 57009, 57011, 57014, 57016 and 57018, from GSC locality C-71460; GSC 57010, 57013 and 57018a, from GSC locality C-71469; GSC 57012 and 57015, from GSC locality C-71465; and GSC 57017, from GSC locality C-71464.

Schizophoria sp. cf. *S. allani* Warren

Plate 2, figures 23 - 28

Material. Represented by a single complete specimen.

Dimensions (mm)

Specimen	A
GSC No.	57019
GSC locality	C-71463
Length of pv	23.4
Length of bv	22.0
Width	23.6
Depth of shell	15.7
Width of interarea	13.2
Depth of sulcus at anterior margin	7.4

Description. Shell of medium size, subequally biconvex, suboval in outline, greatest width about midlength, length and width about equal.

Pedicle valve moderately convex over the umbo, almost flat over the middle of the valve, a shallow, moderately narrow sulcus originates about midlength of valve which becomes deeper, and widens anteriorly and is abruptly deflected at the anterior margin to form a relatively high, sharply V-shaped tongue in the brachial valve. Pedicle beak conspicuous, tapered to a blunt point, slightly incurved. Interarea low, broadly triangular, apsacline. Delthyrium open, narrowly triangular, enclosing an angle of about 27 degrees.

Brachial valve very gibbous, strongly and fairly evenly convex along midline from back to front, highest slightly posterior of midlength. Flanks high, sloping steeply to the lateral margins. Umbonal region strongly and broadly inflated. Beak small, strongly inturned over the lower part of the interarea of the pedicle valve. Interarea very low and broad, projecting very slightly beyond the hinge line, apsacline. A weak narrow fold originates anterior of midlength and extends to the anterior margin.

Both valves ornamented by very fine round-crested, hollow costellae which increase in number anteriorly mainly by implantation but also by bifurcation. Some costellae are slightly larger than others, suggestive of a parvicostellate ornamentation, especially on the pedicle valve. The bases of conspicuous concentric growth lamellae are variably spaced but more crowded toward the anterolateral margins. Between the conspicuous growth lamellae bases are finer, closely spaced growth lines.

Fine closely spaced growth lines are present on both interareas which are parallel to the hinge line.

Shell substance is finely punctate.

Discussion. On such features as oval outline, highly gibbous brachial valve, high, V-shaped uniplicate anterior margin, this form closely resembles *Schizophoria allani* Warren as illustrated by Warren (1944, p. 109, 110, Pl. 1, figs. 4, 5) and Warren and Stelck (1956, Pl. 11, figs. 1 - 3). *Schizophoria lata* differs from the form in the Peace Point Member, being slightly larger at maturity, having a highly inflated brachial umbonal region extending beyond the opposite valve, and in having a relatively straight rather than a curved pedicle interarea.

The form from the Peace Point Member bears some resemblance to *Schizophoria macfarlani* (Meek, 1868, p. 88 - 90, Pl. 12, figs. 1a - 1g) described from Middle Devonian beds of the lower Mackenzie River region. Meek's species, however, is conspicuously longer than wide, has a triangular rather than an oval outline, and the brachial umbo is highly gibbous, incurved and extends well beyond the opposite valve in contrast to a shorter, straighter umbo on the Peace Point form.

Occurrence. Schizophoria sp. cf. *S. allani* Warren is from the basal beds of the Peace Point Member of the Waterways Formation, western part of the Gypsum Cliffs area, Peace River, Alberta. The types of *S. allani* Warren (1944, p. 110) are from beds of the Moberly Member of the Waterways Formation outcropping on the Athabasca River, near Fort McMurray, Alberta.

Figured specimens. GSC 57019 from GSC locality C-71463.

Superfamily Strophomenacea King, 1846

Family Stropheodontidae Caster, 1939

Subfamily Stropheodontinae Caster, 1939

Genus *Strophodonta* Hall, 1850

Type species. *Leptaena demissa* Conrad, 1842, p. 258 (=*Stropheodonta* Hall, 1852, p. 63 (nom. van.))

Strophodonta sp.

Plate 2, figures 29 - 32

Material. Represented by a single abraded pedicle valve.

Dimensions (mm)

Specimen	A
GSC No.	57020
GCS locality	C-71465
Length of pv	16.8
Width of pv	21.8

Description. Pedicle valve of small size, thin, very gently convex, subsemicircular in outline, wider than long, flattened centrally, highest about midlength. Beak small, inconspicuous, projecting a little beyond the hinge line. Interarea wide, flat, very low, apsacline.

Ornamentation radially multicostellate; coarser costellae subangular and stronger umbonally, increasing in number and decreasing in size toward anterolateral margins.

Much finer radial costellae are superimposed on the crests and troughs of the coarser costellae. Ten coarser costellae occur in a space 5 mm of arc at 10 mm from the beak. Concentric growth lines, some highly conspicuous, others very fine and closely spaced. Pseudopunctae evident on abraded exterior parts of shell.

In the interior of the pedicle valve are two ridges contiguous with the pseudodeltidium that extend forward to meet the posterior ends of the adductor scars. Relatively deep pits for the reception of the cardinal process lobes lie on each side of the ridges. The quadripartite adductor muscle field is elliptical in outline, medially divided by a shallow groove. The posterior adductors extend slightly laterally of the anterior pair. Two subflabellate, radially fluted diductor scars extend anterolaterally from the sides of the anterior adductors, extending forward to beyond midlength of valve. A subperipheral rim is present around and about 3 mm in from the lateral and anterior margins of the valve. The inner surface of the valve outside of the muscle scars is marked by tiny pustules arranged in an obscure radial pattern.

Discussion. On size and external features the form from the Peace Point Member bears some resemblance to *Stropheodonta iowensis* Owen as described and illustrated by Stainbrook (1938, p. 250, Pl. 34, figs. 3, 4, 7) from beds equivalent to the *waterlooensis* Zone of the upper Rapid Member of the Cedar Valley Formation of Iowa. It differs from the Iowa form in having a less inflated and less extended pedicle umbo.

Occurrence. *Strophodonta* sp. is from the basal beds of the Peace Point Member of the Waterways Formation, western part of the Gypsum Cliffs area, Peace River, Alberta. Although several species of *Strophodonta* are relatively abundant in the stratigraphically higher Calumet Member of the Waterways Formation, *Strophodonta* is rare in the Firebag Member and equivalent beds. It was previously recorded by Norris (1963, p. 65) from the Peace Point beds as *Strophodonta* sp. B.

Figured specimens. GSC 57020 from GSC locality C-71465.

Order Rhynchonellida Kuhn, 1949

Superfamily Rhynchonellacea Gray, 1848

Family uncertain (?aff. Pugnacidae)

Genus *Ladogioides* McLaren, 1961

Type species. *Ladogioides pax* McLaren, 1961, p. 4, Pl. 1, figs. 6, 7, Pl. 2, fig. C.

Ladogioides pax McLaren

Plate 3, figures 1 - 37, Plate 4, figures 1 - 10

1961 *Ladogioides pax* McLaren, p. 4, Pl. 1, figs. 6, 7, Pl. 2, fig. C.
1962 *Ladogioides pax* McLaren; McLaren, Norris and McGregor, p. 22, Pl. 10, figs. 12 - 14.
1962 *Ladogioides pax* McLaren, p. 66, Pl. 9, figs. 1 - 8, Pl. 10, figs. 1 - 3, Text-fig. 18.
1965 *Ladogioides pax* McLaren; Schmidt and McLaren, in Moore, p. H577, Fig. 450, 2a - 2i.
1971 *Ladogioides pax* McLaren; Harrington, p. 788, Pl. 2, figs. 18 - 27, Pl. 3, figs. 1 - 5.

Material. Represented by 50 complete specimens.

Dimensions (mm)

Specimen	A	B	C	D
GSC No.	57021	57022	57023	57024
GSC locality	C-71468	C-71468	C-71461	C-71468
Length of pv (Lpv)	10.9	12.9	14.6	14.6
Length of bv (Lbv)	9.8	11.5	12.9	13.1
Width (W)	11.5	14.8	14.2	17.2
Depth of shell (D)	4.6	7.3	9.1	8.9
Width of interarea at cardinal margin	5.5	7.5	7.5	8.3
Depth of sulcus at anterior margin	4.2	4.4	8.0	8.1
Ratio: W/Lpv	1.06	1.14	0.97	1.17
Ratio: D/Lpv	0.42	0.56	0.62	0.61
Apical angle (in degrees)	105	105	109	108

Specimen	E	F	G	H
GSC No.	57025	57026	57027	57028
GCS locality	C-71468	C-71466	C-71468	C-71463
Length of pv (Lpv)	18.0	17.6	14.9	20.9
Length of bv (Lbv)	17.0	15.8	13.3	19.2
Width (W)	18.9	17.1	16.3	19.8
Depth of shell (D)	10.6	9.7	13.7	9.3
Width of interarea at cardinal margin	9.2	9.7	8.6	9.4
Depth of sulcus at anterior margin	10.4	7.9	14.5	9.9
Ratio: W/Lpv	1.05	0.97	0.92	0.94
Ratio: D/Lpv	0.59	0.55	0.92	0.44
Apical angle (in degrees)	112	106	117	108

Specimen	1
GSC No.	57029
GSC locality	C-71463
Length of pv (Lpv)	21.8
Length of bv (Lbv)	20.5
Width (W)	27.2
Depth of shell (D)	13.6
Width of interarea at cardinal margin	11.3
Depth of sulcus at anterior margin	11.5
Ratio: W/Lpv	1.24
Ratio: D/Lpv	0.62
Apical angle (in degrees)	125

Description. This form has been very well described and illustrated by McLaren (1962, p. 66 - 71, Pl. 9, figs. 1 - 8, Pl. 10, figs. 1 - 3, Text-fig. 18) based on material from the Peace Point Member of the Waterways Formation at Gypsum Cliffs, Peace River, and also on material from the Firebag Member of the Waterways Formation outcropping on the Clearwater and Athabasca rivers, Alberta. The present description is based only on the Peace Point material, and an attempt is made to depict the wide range of variation in external characters apparent in this material.

Shell commonly of medium size at maturity, outline varying from transversely to elongate subelliptical to subpentagonal, *Pugnoides*-like; width varying from greater than to less than length, greatest width at or anterior of midlength; greatest thickness most commonly at front margin in adults but near midlength in young weakly uniplicate forms; valves of unequal depth, brachial valve generally two-thirds or more total depth of shell; hinge line less than half shell width. Lateral margins broadly rounded. Anterior commissure weakly to strongly uniplicate and crenulated in the midregion.

Pedicle valve is shallow, weakly convex transversely, smoothly and regularly curved longitudinally from beak to posterior end of sulcus. Sulcus begins at or a little posterior to midlength, where it is shallow and ill-defined; anteriorly of this point it abruptly broadens and deepens, forming a broadly rounded shallow U-shaped trough; at about two-thirds length from beak it is strongly deflected dorsally forming a variably shaped tongue in the brachial valve. Anterodorsal end of tongue varies from sharply to rounded V-shaped which in most shells is commonly the highest point of the valve. The crest of tongue on most but not all shells is modified by very coarse costae which cause the commissure to become crenulated. The beak is nearly straight to erect. The interarea is broadly triangular, low, sharp-edged laterally, straight and orthocline in young stages, slightly curved dorsally and weakly anacline in later stages. Delthyrium with two discrete deltidial plates on each side of foramen, but never in contact medially. Foramen is relatively large, longitudinally elliptical, hypothyridid to submesothyridid.

The brachial valve is moderately to highly gibbous, strongly convex transversely, lateral flanks steep. The fold is conspicuous only near the anterior median margin where it is commonly upturned and forms the highest part of valve. The beak is incurved and inconspicuous.

Both valves are covered with very fine, very slightly raised, flattened capillae that increase in number anteriorly by bifurcation. The capillae are separated by exceedingly fine, shallow indentations. Thirteen to seventeen capillae occur in a space of 2 mm along the anterior margin of GSC 57029 (Pl. 4, figs. 8 - 10). The capillae are crossed by exceedingly weakly developed, fine concentric growth lines which are preserved only on the more protected, depressed parts of the shell. Most specimens have broad angular costae on the anterior parts of the shell both medially and on the flanks. The angular costae commonly appear at or forward of midlength of shell and are abruptly accentuated near the anterior and lateral margins of shell. An occasional young adult shell is almost smooth. The costae are separated by angular troughs of about equal width. The costae alternate between the valves and where developed cause strong angular crenulation of the commissure. On the brachial valve there are commonly 3 to 5 costae on the fold and 3 to 6 costae on the flanks; and on the pedicle valve there are 2 to 5 costae in the sulcus and 3 to 5 costae on the flanks. The costae are strongest in the medial part of the shell and diminish in size laterally.

No separated valves of this species have been found, but internal features based on serial sections have been described and illustrated by McLaren (1962, p. 69, Text-fig. 18).

Discussion. *Ladogioides pax* McLaren is distinguished from the stratigraphically younger and geographically separated species, *Ladogioides kakwaensis* McLaren, by the following features noted by McLaren (1962, p. 76): (i) Shells of comparable length are narrower, less inflate, and enclose a smaller apical angle. (ii) Costation is more variable, less angular, with some relatively large shells that are almost smooth. (iii) The interareas and beak ridges are less prominent. (iv) The muscle impressions and pallial sinuses are much less strongly impressed and rarely seen in *L. pax*. (v) There is much greater variation in shape in relation to size increase and in length of shell at which costae first appear.

Ladogioides mollicomus Crickmay (1963, p. 6, Pl. 1, figs. 7 - 9, Pl. 9, figs. 8 - 13), described from the upper part of the Ramparts Formation, Carcajou Ridge area, lower Mackenzie River, differs from *L. pax* in having a more circular outline, a less inflate brachial valve, a less pointed pedicle beak, a lower and broader sulcus on pedicle valve, and by having shorter, more feeble, round-crested costae.

Some young variants of *Ladogioides pax* McLaren superficially resemble *L. asmenista* (Crickmay) (1963, p. 10, Pl. 3, figs. 1 - 4, Pl. 9, figs. 14 - 19) described from beds of the Calumet Member outcropping on Athabasca River, northern Alberta. *Ladogioides pax* McLaren is distinguished from *L. asmenista* (Crickmay) by the presence of a distinctive radial micro-ornament, by attaining a much larger size at maturity, and having a more conspicuous pedicle interarea.

Ladogioides n. sp., illustrated by Maurin and Raasch (1972, Pl. 3, Pl. 10, figs. 1 - 4) from about the middle of their Assemblage IV in the Flume Formation at Kakwa Lake, British Columbia, bears some superficial resemblance to weakly costate specimens of *L. pax* McLaren from the Peace Point beds. *Ladogioides pax* is distinguished from this new species by a smaller, more sharply pointed pedicle beak, by a much lower and more angular pedicle interarea, and by more angular and more strongly developed costae.

Occurrence. *Ladogioides pax* McLaren occurs typically and abundantly in the lower beds of the Peace Point Member of the Waterways Formation, western Gypsum Cliffs, Peace River, Alberta. It occurs less abundantly in the stratigraphically equivalent beds of the Firebag Member of the Waterways Formation outcropping on Clearwater and Athabasca rivers. It occurs also in the basal beds of the Hay River Formation outcropping near Sulphur Bay on the northwest side of Great Slave Lake (Norris, 1965, p. 85).

"*Ladogioides* cf. *pax* McLaren" has been recorded by Crickmay (1966, p. 16) from core in the interval 137.2 - 161.6 m in the N.W.T. Deep Bay No. 3 well (61°20'00"N, 116°42'30"W) located about 38.7 km west of Sulphur Bay on the northwest side of Great Slave Lake. The base of this interval is about 35.1 m above the base of the Hay River Formation in this well (Oil and Gas Section, Resources Division, 1964, p. 28, 29).

Ladogioides pax McLaren has been described and illustrated by Harrington (1971, p. 788, 789, Pl. 2, figs. 18 - 27, Pl. 3, figs. 1 - 5) from a thin interval 67.1 - 73.2 m above the base of the Weatherall Formation, which is 792.5 m thick, outcropping on northeastern Banks Island, N.W.T.

In the three areas where this species is presently known, that is northern Alberta, southern District of Mackenzie, and Banks Island in the Canadian Arctic, it appears to have rather limited range within the Peace Point and Firebag Members of the Waterways Formation, basal Hay River Formation, and lower Weatherall Formation, respectively. *Ladogioides pax* McLaren and *L. kakwaensis* (McLaren) were designated by McLaren (1962, p. 15) as indices for the lowest rhynchonellid zone of the Upper Devonian in western Canada. McLaren assumed that these two species were approximately contemporaneous although they occur in different areas. As stated elsewhere, *L. kakwaensis* occurs in slightly younger beds.

Figured specimens. GSC 57021, 57022, 57024, 57025 and 57027, from GSC locality C-71468; GSC 57023 from GSC locality C-71461; GSC 57026 from GSC locality C-71466; and GSC 57028 and 57029 from GSC locality C-71463.

Family Camarotoechiidae Schuchert and LeVene, 1929

Subfamily Camarotoechiinae Schuchert and LeVene, 1929

Genus *Platyterorhynchus* Sartenaer, 1970

Type species. *Leiorhynchus russelli* McLaren, 1962, p. 95, Pl. 17, figs. 1 - 10, Text-figs. 27, 28

Platyterorhynchus russelli (McLaren)

Plate 4, figures 11 - 39

1962 *Leiorhynchus* sp., McLaren, Norris and McGregor, p. 22, Pl. 10, figs. 15 - 17.
1962 *Leiorhynchus russelli* McLaren, p. 95, Pl. 17, figs. 1 - 10.
1970 *Platyterorhynchus russelli* (McLaren); Sartenaer, p. 5, 6.
1972 *Leiorhynchus carya* Crickmay; Maurin and Raasch, Pl. 10, figs. 8 - 15.

Material. Represented by 66 complete specimens and 10 separated valves or fragmentary specimens.

Dimensions (mm)

Specimen	A	B	C	D
GSC No.	57030	57031	57032	57033
GSC locality	C-71466	C-71466	C-71466	C-71466
Length of pv (Lpv)	8.0	18.5	23.4	23.3
Length of bv (Lbv)	7.4	16.5	22.4	21.9
Width (W)	8.3	19.0	23.7	25.0
Depth of shell (D)	3.1	9.0	9.8	15.2
Width of interarea at cardinal margin	2.7	6.8	9.2	12.3
Depth of sulcus at anterior margin	0	2.9	3.8	5.5
Ratio: W/Lpv	1.03	1.02	1.01	1.07
Ratio: D/Lpv	0.38	0.48	0.42	0.65
Apical angle (in degrees)	96	124	126	116

Specimen	E	F	G
GSC No.	57034	57035	57036
GSC locality	C-71466	C-71463	C-71461
Length of pv (Lpv)	24.1	27.6	13.6+
Length of bv (Lbv)	22.9	26.5	-
Width (W)	25.7	28.9	15.2+
Depth of shell (D)	13.8	16.6	-
Width of interarea at cardinal margin	12.1	13.0	-
Depth of sulcus at anterior margin	3.6	6.7	-
Ratio: W/Lpv	1.06	1.04	1.11
Ratio: D/Lbv	0.57	0.60	-
Apical angle (in degrees)	122	111	-

Description. Shell of medium to large size for the genus, subpentagonal to subcircular in outline, width greater than length, greatest width slightly anterior of midlength,

subequally to almost equally biconvex. Apical angle varies from 96 to 126 degrees, with an arithmetic mean of about 116 degrees in the material at hand. Lateral margins smoothly rounded. Fold and sulcus weakly costate to smooth anteriorly, umbones inflate and smooth, coastae weak and rare on flanks. Anterior commissure rectimarginate in young specimens, weakly and broadly uniplicate in adult specimens.

The pedicle valve is weakly to moderately convex from back to front along the midline, commonly highest at about one-third length from beak, lateral flanks gently convex to almost flat to very slightly concave. The sulcus is shallow, broadly U-shaped, commonly developed in the anterior third of the shell, ending in a shallow rounded tongue. The beak is strongly incurved, interareas very low and commonly concealed in adult specimens. The foramen is elongate, parallel sided, and rounded posteriorly, permesothyridid to epithyridid. Deltidial plates not evident.

The brachial valve is weakly to moderately convex with maximum height at or posterior to midlength, lateral slopes moderately convex. The fold is low, broad, and is present only near the front margin and is lacking on some specimens. The beak is incurved and hidden by the pedicle valve.

The costal ornament is highly variable and some shells are smooth. Commonly 3 to 4, with a maximum of 6, low, rounded irregular costae, some of which may bifurcate, are developed on the anterior part of the fold and sulcus. Very weakly developed costae, up to about 6 in number, are rarely present on the anterior parts of the flanks. Traces of very fine microradial markings are apparent on one specimen (GSC 57032) where the shell material is well preserved. Fine concentric growth lines are also apparent on well preserved shells. Shell material is exceedingly thin and is commonly partly missing from most of the specimens in the Peace Point material.

In the brachial valve, a median septum extending anteriorly about one-half length of shell is apparent on exfoliated specimens. Muscle impressions and other markings in the interiors of the valves are very weakly impressed judging from exfoliated specimens. Other internal features are described and illustrated by McLaren (1962, Text-figs. 27, 28) based on serial sections.

Discussion. This form is characterized by its smoothly subpentagonal to circular outline, the weakly and irregularly developed coarse costation, many shells being nearly smooth, and by the conspicuous elongate permesothyridid to epithyridid foramen. McLaren (1962, p. 100) indicated that internally the cardinalia are slender and less thickened than in most species of *Leiorhynchus*, some of which have since been distinguished as separate genera by Sartenaer (1970, 1975).

Small specimens of *Platyterorhynchus russelli* may resemble small forms of *Ladogioides pax* which occur in the same beds, but are readily distinguished by either a lack of or a distinctively different micro-ornament and by a difference in beak structure.

Occurrence. Platyterorhynchus russelli is one of the more abundant elements in the Peace Point Member of the Waterways Formation, western part of the Gypsum Cliffs area, Peace River, Alberta. It has been recorded also as *Ladogia*(?) sp. by Norris (1963, p. 66) in collections from outcrops along Birch River southwest of Lake Claire, Alberta, south of Gypsum Cliffs, and as *Ladogioides*? sp. B (Norris, 1963, Fig. 6) from outcrops of the Firebag Member along Athabasca River where it is exceedingly rare.

From the subsurface of the Fort McMurray area, Crickmay (1966, p. 20) recorded "*Leiorhynchus* cf. *russelli* McLaren" and "*Leiorhynchus russelli* McLaren" from the intervals 493.8 - 512.7 m and 460.8 - 483.8 m respectively, in the Bear Biltmore No. 1 well (7-11-87-17 WPM). These intervals are within the Firebag Member of the Waterways Formation.

From the Rocky Mountains of east-central British Columbia, McLaren (1962, p. 100, 120) recorded *P. russelli* from beds 70.1 m above the base of the Devonian on the northeast flank of Wallbridge Mountain, near Cecilia Lake (GSC loc. 35103); and from the Flume Formation at Kakwa Lake in the same region (45°03'N, 120°10'W; GSC loc. 35102).

From farther north in British Columbia, *P. russelli* has been collected from argillaceous limestone beds assigned to the "Flume Formation equivalent" about 30.5 m below the base of a shale unit ("Perdrix equivalent"), near Nabesche River at 56°17'N, 123°23'W (McLaren, 1962, p. 100, 122).

From the Kakwa Lake area, British Columbia, Maurin and Raasch (1972, Pls. 1, 3) recorded *P.* cf. *russelli* from the upper part of the Flume Formation in sample 502 from their KW3 section. In addition, the form designated as *Leiorhynchus carya* by Maurin and Raasch (1972, Pl. 10, figs. 8 - 15) from the upper part of the Flume Formation at Wallbridge Mountain and Kakwa Lake appears to be more closely related to *Platyterorhynchus russelli* than to *Leiorhynchus carya*.

Figured specimens. GSC 57030, 57031, 57032, 57033 and 57034 from GSC locality C-71466; GSC 57035 from GSC locality C-71463; and GSC 57036 from GSC locality C-71461.

Platyterorhynchus russelli (McLaren) Form A , new

Plate 4, figures 40 - 42, Plate 5, figures 1 - 7

Material. Represented by 2 complete specimens and 4 fragmentary specimens.

Dimensions (mm)

Specimen	A	B	C
	Paratype	Paratype	Holotype
GSC No.	57037	57038	57039
GSC locality	C-71466	C-71469	C-71466
Length of pv (Lpv)	18.3	17.4+	23.0
Length of bv (Lbv)	17.6	14.3+	21.8
Width (W)	19.7	22.6	26.4
Depth of shell (D)	13.0	14.1	15.5
Width of interarea at cardinal margin	10.9	11.5	12.3
Depth of sulcus at anterior margin	5.6	8.8	9.4
Ratio: W/Lpv	1.07	1.29	1.15
Ratio: D/Lpv	0.71	0.81	0.67
Apical angle (in degrees)	114	103	114

Description. Shell of medium size at maturity, subpentagonal in outline, width generally greater than length, greatest width at or posterior to midlength, almost equally biconvex, apical angle varies from 103 to 114 degrees in material at hand, flanks smooth to very weakly costate anteriorly, fold and sulcus moderately to weakly costate anteriorly, smooth highly inflated umbones, anterior commissure uniplicate in adult specimens.

Pedicle valve moderately to strongly convex from back to front along midline, accounting for about one-half thickness of shell, highest at one-third length from beak, flanks gently convex to almost flat. The sulcus is confined to anterior third of shell, is shallow, broadly U-shaped, deepens anteriorly, and is strongly deflected dorsally to form a rounded tongue in the opposite valve. The beak is strongly incurved; interarea is concealed by opposite valve in adult specimens. The foramen is small, parallel-sided, and rounded posteriorly, epithyridid. Deltidial plates not evident.

The brachial valve is moderately to strongly convex with maximum height at about one-third length from beak, lateral slopes moderately convex. The fold is low, broad, distinct only in anterior third of shell. The umbo is broadly rounded and highly inflated. The beak is incurved and hidden by pedicle valve.

Shell is ornamented by weak, broad costae on the anterior parts of the fold and sulcus; costae on the anterior parts of the flanks are exceedingly weak or commonly absent. In the specimens at hand, three costae are present on the fold and in the sulcus forming a crenulated anterior margin where the alternating costae on opposing valves intersect one another. Fine radial markings and concentric growth lines are evident only on well preserved parts of shell. Shell material is thin and commonly exfoliated.

Median septum in brachial valve extends along midline from near tip of beak to about one-half length of valve.

Discussion. This informally designated new form A is distinguished from *Platyterorhynchus russelli* by being proportionately much thicker and wider throughout its young and adult growth stages. The umbones of both valves, especially that of the pedicle valve, are much more highly inflated than in *P. russelli*. This stout variant may be a dimorph or a distinctly new subspecies but is not formally named because of a lack of sufficient material.

Occurrence. This form is relatively rare in the Peace Point Member of the Waterways Formation, western Gypsum Cliffs area, Peace River, Alberta.

Figured specimens. Paratype 57037 and holotype 57039 from GSC locality C-71466; paratype 57038 from GSC locality C-71469.

Order Atrypida Rzhonsnitskaya, 1960

Family Atrypidae Gill, 1871

*Genus *Desquamatia* Alekseeva, 1960; Biernat, 1964

Type species. *Atrypa (Desquamatia) khavae* Alekseeva, 1960

Subgenus *Independatrypa* Copper, 1973

Type species. *Atrypa independensis* Webster, 1921, p. 15 (see Fenton and Fenton, 1935).

Desquamatia (Independatrypa) independensis (Webster)

Plate 5, figures 14 - 33, Plate 8, figures 5, 6

1921 *Atrypa independensis* Webster (part), p. 15 (not Pl. 8, figs. 4 - 6).
1932c *Atrypa independensis* Webster; Fenton and Fenton, p. 206, Pl. 21, figs. 1 - 4, Text-fig. 1.
1935 *Atrypa independensis* Webster; Fenton and Fenton, p. 377, Pl. 41, figs. 9 - 12, Pl. 42, figs. 14 - 16, Pl. 43, fig. 12.
1935 *Atrypa expansa* Webster, 1921, p. 15; Fenton and Fenton, p. 377.
1938 *Atrypa independensis* Webster; Stainbrook, p. 229, Pl. 30, figs. 10, 15, 16.
1956 *Atrypa independensis* Webster; Warren and Stelck, Pl. 10, figs. 11 - 13.
1960 *Atrypa independensis* Webster; McCammon, p. 53, Pl. 9, figs. 1 - 4.
1973 *Desquamatia (Independatrypa) independensis* (Webster); Copper, p. 493, Pl. 1, figs. 1, 2, Pl. 2, fig. 16.

Material. Represented by 104 calcareous specimens, and some fragmentary specimens.

Dimensions (mm)

Specimen	B	C	D	E
GSC No.	57041	57042	57043	57044
GSC locality	C-71465	C-71463	C-71466	C-71463
Length of pv (Lpv)	25.3	24.4	30.5	31.9
Length of bv (Lbv)	24.9	23.4	29.5	31.0
Width (W)	ca 21.9	24.0	30.9	30.1
Depth of shell (D)	14.3	13.6	15.6	18.2
Hinge line length	11.6	12.2	15.5	15.4
Hinge angle (in degrees)	141	157	163	153
Depth of sulcus at anterior margin	4.8	7.8	7.6	13.6
Ratio: W/Lpv	0.87	0.98	1.01	0.94
Ratio: D/Lpv	0.57	0.56	0.49	0.57

*The taxonomy of many of the atrypids of western Canada, including some of the genera and subgenera considered in this report, are revised in a paper by P. Copper (1978). The paper by Copper was mentioned by D.G. Perry (pers. com., Sept. 25, 1978) as being in press but was not seen by Norris until after it was published and after this report had been completed.

Specimen	F	G	H
GSC No.	57045	57046	57080
GSC locality	C-71468	C-71466	C-71469
Length of pv (Lpv)	32.6	33.4	27.1
Length of bv (Lbv)	32.1	32.3	26.4
Width (W)	32.0	35.0	28.3
Depth of shell (D)	20.0	17.0	13.7
Hinge line length	15.0	25.9	19.5
Hinge angle (in degrees)	147	157	157
Depth of sulcus at anterior margin	6.6	12.0	5.4
Ratio: W/Lpv	0.98	1.05	1.04
Ratio: D/Lpv	0.61	0.51	0.51

Description. Shell attains a medium to large size, subequally biconvex in lateral profile in young stages, tending to a highly inflated planoconvex profile in adult and gerontic stages; outline suboval in young stages to subsemicircular in adult stages; generally wider than long with greatest width at about one-third to one-half length from apex; posterolateral extremities commonly extended but rounded; lateral margins broadly rounded and broadly convex ventrally; anterior commissure rectimarginate in young stages, unevenly and moderately to strongly uniplicate in mature stages.

Pedicle valve gently arched along the midline from back to front; highest immediately anterior of the umbo; gently arched transversely, most strongly elevated in the umbonal region, flattened and recurved to become concave toward the posterolateral and lateral margins. Sulcus absent in young stages, becoming variably rounded U-shaped to rounded V-shaped and upturned in roughly anterior third of adult shells. Beak small, pointed, very short, erect in young stages, moderately incurved in later stages. Interarea low, relatively wide, round-edged laterally, apsacline in very young stages, changing to anacline and largely covered in adult stages. Delthyrium with two wedge-shaped deltidial plates easily distinguished from ventral interarea and pierced apically by a submesothyridid to mesothyridid oval-shaped foramen having a slightly raised rim.

Brachial valve is nearly equal in convexity to that of the opposite valve in very young stages but becomes highly inflated in later stages to make up about three-quarters of the depth of the shell. Strongly convex along the midline from back to front, highest at one-third to one-half length from beak; flanks slope steeply laterally and anterolaterally, recurved toward posterolateral extremities. Fold indistinct, most evident at and near anterior margin of shell in older specimens. Beak small, strongly incurved and hidden by opposite valve.

Surface of both valves ornamented by very fine radiating, round-crested costae which increase in number anteriorly by bifurcation and implantation. They are separated by rounded troughs of equal width. Costae increase in size gradually anteriorly. Concentration of costae at 10 mm from the apex varies from 17 to 32 and averages 24 per 10 mm of arc; at 20 mm from the apex the concentration of costae varies from 16 to 29 and averages 21 per 10 mm of arc.

Concentric growth lamellae are relatively strong and conspicuous on both valves, imparting a ragged appearance to the shell. Parts of the alate lamellae are preserved on matrix of GSC 57045 where they are very thin, fragile, and project at an oblique angle from the shell. The same pattern of radial costae is present on the alate lamellae.

Microscopic concentric growth lines preserved mainly in the troughs separating costae are concentrated at 9 to 18 and average 13 per mm on shell surface.

Discussion and comparison. Desquamatia (Independatrypa) independensis is distinguished from the closely related *Desquamatia (Variatrypa) klukasi* n. sp. by its more conspicuous development of growth lamellae imparting a ragged and uneven appearance to the shell; by its more highly inflated brachial valve; by its more pronounced and irregularly shaped unisulcate anterior margin, and by its more pronounced development of the posterolateral extremities; as well as other more subtle shape differences.

The specimen illustrated by Whiteaves (1892, Pl. 27, fig. 8) from Pentamerus Point, Lake Manitoba, showing a beautifully preserved marginal frill is from the Winnipegosis Formation. Although placed in synonymy with *Desquamatia (Independatrypa) independensis* by some authors, the form from the Winnipegosis Formation of Manitoba is more closely related to *Desquamatia (Variatrypa) arctica* (Warren) which is one of the more abundant elements in the underlying Elm Point Formation or Lower Member of the Winnipegosis Formation of Manitoba.

Occurrence. Desquamatia (Independatrypa) independensis occurs abundantly in the lower part of the Peace Point Member of the Waterways Formation, western part of Gypsum Cliffs area, Peace River, northern Alberta.

In the McMurray area of northern Alberta, Crickmay (1966, p. 17, 20, 21) recorded *Desquamatia (Independatrypa) independensis* (Webster) from the lower 18.9 m of the Firebag Member between the depths of 493.8 - 512.7 m of the Waterways Formation in the Bear Biltmore No. 1 well; and from the lower 16.8 m of the Firebag Member between depths of 130.5 - 147.2 m of the Waterways Formation in the Bear Rodeo No. 1 well.

From the Devonian outcrop belt of southwestern Manitoba, McCammon (1960, p. 54, Pl. 9, figs. 1 - 4) recorded *Desquamatia (Independatrypa) independensis* (Webster) from both the Dawson Bay and Souris River formations. More recent work on the Devonian of Manitoba (Norris et al., 1982) indicates that *D. (I.) independensis* is restricted to the Argillaceous limestone beds of the Point Wilkins Member of the Souris River Formation. The conodont fauna of these beds cannot be assigned to any established zone but, on the basis of stratigraphic position, should belong to the Upper *Polygnathus varcus* Subzone and/or the *Schmidtognathus hermanni - Polygnathus cristatus* Zone.

In Iowa, *Desquamatia (Independatrypa) independensis* (Webster) occurs typically in the lower part of the Solon Limestone of the Cedar Valley Formation and the beds containing this form are referred to as the *independensis* Zone (Stainbrook, 1941, p. 324). The lower part of the Solon Member contains conodonts assignable to the upper part of the Middle *varcus* Subzone (Ziegler et al., 1976, Fig. 3).

Remarks. Numerous specimens of this species from the Peace Point Member display irregular markings around the anterior and lateral margins of the shell caused presumably by a parasitic or symbiotic boring organism (see Pl. 8, figs. 5, 6).

Figured specimens. GSC 57043 and 57046 from GSC locality C-71466; GSC 57041 from GSC locality C-71465; GSC 57042 and 57044 from GSC locality C-71463; and GSC 57045 from GSC locality C-71468.

Desquamatia (Independatrypa)
sp. cf. *D. (I.) independensis* (Webster)

Plate 8, figures 7 - 11

Material. Represented by 8 poorly preserved specimens, most of which are partly embedded in matrix.

Dimensions (mm)

Specimen	A
GSC No.	57081
GSC locality	46322
Length of pv (Lpv)	30.1+
Length of bv (Lbv)	30.0
Width (W)	29.6
Depth of shell (D)	18.8
Hinge line length	17.8
Hinge angle (in degrees)	138
Depth of sulcus at anterior margin	5.2
Ratio: W/Lpv	0.98
Ratio: D/Lpv	0.62

Description. Shell attains a medium size at maturity, unequally biconvex, tending to a planoconvex profile in adult stages, suboval in outline, generally wider than long with greatest width at about midlength, rare individuals slightly longer than wide; posterolateral extremities rounded; lateral margins broadly rounded and convex ventrally; anterior commissure moderately uniplicate in adult stages.

Pedicle valve slightly convex from beak to front margin, greatest curvature over umbo, flattening laterally and slightly concave posterolaterally, a very shallow sulcus present in medial anterior third of valve, extended as broadly rounded tongue in pedicle valve. Beak broad, low, bluntly tapered, incurved in adults, more pointed and less incurved in young forms.

Brachial valve moderately to very strongly convex, accounting for three-quarters or more of the total thickness of shell, highest about midlength, lateral slopes steep and gently convex, flattening and slightly concave toward cardinal extremities. Fold indistinct, very slightly evident on anterior medial third of valve. Umbo highly inflated and broadly rounded; beak strongly inturned and hidden by opposite valve.

Surface of both valves ornamented by relatively fine radiating round-crested costae which increase anteriorly by bifurcation. They are separated by rounded troughs of slightly less or about equal width. Concentration of costae at 10 mm from beak is about 10 per 5 mm of arc; at 20 mm from the beak the concentration is about 12 per 5 mm of arc. Concentric growth lamellae are irregularly spaced, relatively strong, and best preserved on specimens partly embedded in matrix.

Discussion. The relative scarcity and poor preservation of material from Slave Point beds precludes a detailed comparison with other forms. However, as this form is the most abundant of a sparse fauna in the Slave Point Formation and commonly mentioned in the literature, it warrants description and illustration. On the basis of shell shape, lateral profile and size of costae, this form closely resembles *Desquamatia (Independatrypa) independensis* (Webster) as described and illustrated by Stainbrook (1938, p. 229 - 231, Pl. 30, figs. 10, 15, 16) from the *independensis* Zone of the basal Cedar Valley beds of Iowa. Some of the specimens from the Slave Point Formation appear to have slightly coarser and more widely spaced coastae. The form from the Slave Point beds also differs from the Iowa form in having a suboval rather than a subsemicircular outline.

Occurrence. This form was collected from GSC localities 46359, 46322 and 46362 from the upper 2.5 m of the Slave Point Formation at Stations 261NB and 262NB on the west bank of Peace River 2.7 km above the upper end of Boyer Rapids.

Figured specimens. GSC 57081, a relatively large adult specimen, from GSC locality 46322.

Genus *Desquamatia* Alekseeva, 1960; Biernat, 1964

Type species. *Atrypa (Desquamatia) khavae* Alekseeva, 1960

Subgenus *Variatrypa* Copper, 1966

Type species. *Desquamatia ajugata* Copper, 1965

Desquamatia (Variatrypa) clarkei (Warren)

Plate 5, figures 34 - 48, Plate 6, figures 1 - 6

1944 *Atrypa clarkei* Warren, p. 122, Pl. 3, figs. 10 - 12.
1956 *Atrypa clarkei* Warren; Warren and Stelck, Pl. 12, figs. 5 - 7.

Material. Represented by 75 complete calcareous specimens.

Dimensions (mm)

Specimen	A	B	C	D
GSC No.	57047	57048	57049	57050
GSC locality	C-71451	C-71470	C-71470	C-71470
Length of pv (Lpv)	15.9	24.8	25.1	30.1
Length of bv (Lbv)	15.2	24.1	24.5	29.3
Width (W)	17.1	24.9	26.0	31.2
Depth of shell (D)	8.5	13.9	14.6	19.9
Hinge line length	11.6	21.8	21.8	17.5
Hinge angle (in degrees)	153	152	154	154
Depth of sulcus at anterior margin	0	2.9	3.4	11.1
Ratio: W/Lpv	1.08	1.00	1.04	1.04
Ratio: D/Lpv	0.53	0.56	0.58	0.66

Specimen	E
GSC No.	57051
GSC locality	C-71465
Length of pv (Lpv)	31.1
Length of bv (Lbv)	30.2
Width (W)	33.5
Depth of shell (D)	15.1
Hinge line length	26.8
Hinge angle (in degrees)	148
Depth of sulcus at anterior margin	1.7
Ratio: W/Lpv	1.08
Ratio: D/Lpv	0.49

Description. Shell of medium size at maturity, subovate outline, nearly equally biconvex in young stages, becoming biconvex in mature stages with the brachial valve 1.5 to 3 times thicker than the opposite valve. Hinge line is relatively straight. Posterolateral extremities are generally rounded and occasionally subangular. Lateral commissures well rounded. Anterior commissure rectimarginate in young stages and broadly and weakly uniplicate in adult stages.

Pedicle valve is moderately convex along the midline and is highest at about one-third length from beak; curvature decreases laterally and anteriorly and reverses curvature to become slightly concave laterally in adult specimens. In some adult specimens a very broad, ill-defined very shallow sinus is developed in the anterior quarter of the valve. The beak is small, pointed, and pierced by a small roughly oval submesothyridid to mesothyridid foramen. In gerontic specimens the pedicle beak is closely inturned against the opposite valve and the foramen is closed. The interarea is relatively low and wide and round-edged laterally. The delthyrium has two wedgelike deltidial plates which abut and appear to overlap in one young specimen and is partly open in some older specimens. A slightly raised rim occurs on the plates where they are pierced by the foramen.

The brachial valve is moderately to strongly convex, highest at one-quarter to one-half length from beak. A flattening and slight reversal of curvature occurs toward the posterolateral extremities. There is no distinct fold on the valve. A slightly indented trough occurs along the midline over the umbo of young specimens. Beak and interarea are hidden by opposite valve in all adult specimens, and in young specimens can be seen to be closely inturned against the opposite valve.

Both valves are ornamented by very fine costae which increase by bifurcation on the pedicle valve and by intercalation and bifurcation on the brachial valve. They are straight in the midareas, but are curved laterally on flanks. Costae are well defined, relatively high, narrow, with round crests and deep, round troughs. Costal increase in size is gradual anteriorly. Concentration of costae at 10 mm from apex varies from 20 to 27 per 10 mm of arc and averages 24; and at 20 mm from apex the concentration varies from 18 to 23 per 10 mm and averages 20 per 10 mm of arc.

Concentric growth lamellae are very weakly developed, relatively widely spaced, and on some specimens are almost totally absent resulting in a smooth appearance of the shell. Where growth lines are present they tend to be more closely spaced and conspicuous toward the lateral and anterior margins of the shell.

Microscopic growth lines preserved mainly in the troughs separating the costae are concentrated at 7 to 11 per mm.

Internal structure not evident.

Discussion and comparison. Information on the horizon and locality for *Desquamatia (Variatrypa) clarkei* was given by Warren (1944, p. 123) only in very broad and general terms. It is highly likely, however, judging from the information given in a later publication by Warren and Stelck (1956, explanation for Pl. 12), that the type specimens were collected from beds of the Moberly Member of the Waterways Formation outcropping on the Athabasca River near Fort McMurray. The type specimens are therefore from beds that are younger than the Peace Point Member of the Waterways Formation.

In the Peace Point beds, *Desquamatia (Variatrypa) clarkei* appears to represent the end member of a continuous series in variation of forms between almost total absence to very pronounced development of alate lamellae. Specimens showing variable development of alate lamellae are much more common than specimens showing a weak development of this feature, and in this report are arbitrarily distinguished from *Desquamatia (Variatrypa) clarkei* as a new species named *Desquamatia (Variatrypa) klukasi*, which is described below.

The lack of or weak development of alate lamellae is a youthful feature that persists into adult stages in *Desquamatia (Variatrypa) clarkei* and appears to be an example of neoteny.

Desquamatia (Variatrypa) clarkei is easily distinguished from *Desquamatia snakensis* (McCammon, 1960, p. 53, Pl. 9, figs. 5 - 9) occurring in Members B, C and D of the Dawson Bay Formation of Manitoba (Norris et al., 1982) by its much finer and more even costae, by its much smaller and more curved pedicle beak, and by its more circular shape in adult stages.

Desquamatia (Variatrypa) clarkei, on the feature of exceedingly fine costation, is closely comparable to *Desquamatia (Variatrypa) arctica* (Warren, 1944, p. 120, Pl. 3, figs. 19 - 21), the types of which are from the Anderson River area and presumably from the upper part of the Hume Formation. *Desquamatia (Variatrypa) arctica* occurs below the *Leiorhynchus castanea* (Meek) fauna and is, therefore, considerably older than *Desquamatia (Variatrypa) clarkei*. The latter form is distinguished from *Desquamatia (Variatrypa) arctica* by its more circular outline, by its almost complete lack of a fold and sulcus on the brachial and pedicle valves, and by its weaker development of alate lamellae. Well preserved alate lamellae on *Desquamatia (Variatrypa) arctica* are known from a number of localities, including the Elm Point Formation of southwestern Manitoba, the lower Methy Formation of northwestern Saskatchewan, and from the lower part of the Pine Point Formation on the south side of Great Slave Lake.

From the associated *Desquamatia (Variatrypa) klukasi* n. sp., *Desquamatia (Variatrypa) clarkei* is distinguished by its weak development or absence of alate growth lamellae. On other features the two forms are obviously very closely related.

Occurrences. *Desquamatia (Variatrypa) clarkei* is abundantly represented in the lower part of the Peace Point Member of the Waterways Formation, western part of the Gypsum Cliffs area, Peace River, northern Alberta.

Figured specimens. GSC 57047 from GSC locality C-71451; GSC 57048, 57049 and 57050 from GSC locality C-71470; and GSC 57051 from GSC locality C-71465.

Desquamatia (Variatrypa) klukasi n. sp.

Plate 6, figures 7 - 39

Derivation of name. Trivial name after Herman Klukas, one of the early rangers of Wood Buffalo National Park, which was created in 1922.

Material. Represented by 246 calcareous complete specimens and 58 incomplete specimens. This is the most abundant brachiopod in the Peace Point Member of the Waterways Formation in the Gypsum Cliffs area.

Dimensions (mm)

Specimen	A	B	C	D
	Paratype	Paratype	Paratype	Paratype
GSC No.	57052	57053	57054	57055
GSC locality	C-71463	C-71468	C-71460	C-71469
Length of pv (Lpv)	20.4	23.1	24.9	24.2
Length of bv (Lbv)	19.6	22.3	24.4	23.3
Width (W)	21.0	23.6	24.5	25.3
Depth of shell (D)	10.5	14.4	13.3	11.5
Hinge line length	15.6	14.4	15.6	16.4
Hinge angle (in degrees)	151	137	145	154
Depth of sulcus at anterior margin	1.4	5.6	2.8	0
Ratio: W/Lpv	1.03	1.02	0.98	1.05
Ratio: D/Lpv	0.51	0.62	0.53	0.48

Specimen	E	F	G	H
	Paratype	Paratype	Paratype	Holotype
GSC No.	57056	57057	57058	57059
GSC locality	C-71460	C-71463	C-71460	C-71460
Length of pv (Lpv)	24.6	24.1	27.4	29.6
Length of bv (Lbv)	23.6	23.1	26.2	29.3
Width (W)	25.3	24.3	27.2	31.7
Depth of shell (D)	12.3	12.4	17.5	16.9
Hinge line length	20.3	15.2	19.0	20.8
Hinge angle (in degrees)	155	153	152	158
Depth of sulcus at anterior margin	4.3	1.5	4.2	5.8
Ratio: W/Lpv	1.03	1.01	0.99	1.07
Ratio: D/Lpv	0.50	0.51	0.64	0.57

Specimen	I	J
	Paratype	Paratype
GSC No.	57060	57061
GSC locality	C-71463	C-71463
Length of pv (Lpv)	30.5	27.1
Length of bv (Lbv)	31.0	-
Width (W)	33.6	25.8
Depth of shell (D)	19.0	-
Hinge line length	22.0	11.9
Hinge angle (in degrees)	158	-
Depth of sulcus at anterior margin	5.7	-
Ratio: W/Lpv	1.10	0.95
Ratio: D/Lpv	0.62	-

Description. Shell of medium to large size at maturity, subovate to subsemicircular in outline, widest about midlength, nearly equally biconvex in young stages, becoming markedly biconvex in adult stages, with the brachial valve 1.5 to 4 times as thick as the pedicle valve. Hinge line short, varying from straight to slightly curved and sloping gently away from the midline. Posterolateral extremities are generally rounded and rarely subangular. Lateral commissures broadly rounded. Anterior commissure rectimarginate in young stages, and broadly and weakly uniplicate in adult stages.

Pedicle valve is weakly to moderately convex along the midline, with greatest curvature in the umbonal region, and highest at one-fifth to one-half length from beak, flattening and reversing curvature posterolaterally and laterally to become slightly concave, sloping gradually to front margin. A broad shallow sulcus is developed in the medial part of the anterior quarter to third of the valve in adult specimens. The beak is small, low, and broad, strongly incurved in adult stages, more pointed and less incurved in young forms. Cardinal area orthocline in young stages and strongly anacline in late growth stages. Interarea low and broad in yound specimens and covered by brachial valve in older specimens. Pedicle opening submesothyridid in young stages, surrounded by a narrow slightly raised rim, becoming mesothyridid in later growth stages, and closed and closely inturned against opposite valve in mature growth stages. Delthyrium with two wedge-shaped deltidial plates that abruptly widen anteriorly and are fused medially. A rounded slightly raised rim occurs on apical ends of plates where pierced by foramen, evident on one specimen.

The brachial valve is moderately to very strongly convex along the midline, generally highest about midlength. Curvature flattens and reverses to become concave toward the posterolateral corners which in gerontic specimens are greatly extended and strongly reflexed. A distinct fold is lacking on the valve. Beak is inturned and hidden by opposing valve.

Valves are ornamented by very fine costae which increase mainly by bifurcation on the pedicle valve and by intercalation and bifurcation on the brachial valve. Costae

are relatively even, high, narrow, with rounded crests, separated by rounded troughs of about equal depth and width. They increase in size very gradually anteriorly. Concentration of costae at 10 mm from the apex varies from 17 to 32 and averages 23 per 10 mm of arc; and the concentration at 20 mm from the apex varies from 16 to 26 and averages 20 per 10 mm of arc. Pedicle interarea is covered with very fine closely spaced striations parallel to hinge line.

Concentric growth lamellae bases are moderately developed and widely spaced up to about 10 mm apart and generally more closely spaced toward the anterior and lateral margins of shell. Where partly preserved, the alate lamellae are exceedingly thin and fragile and presumably very easily broken.

Microscopic concentric growth lines, 13 to 19 per mm, are preserved mainly in the troughs separating the costae.

Internal features can be seen in a single free pedicle valve of GSC 57061. A narrow, elongate, deeply impressed adductor muscle impression occurs along the midline immediately anterior of the umbonal cavity. A deeply impressed spatula-shaped diductor muscle impression occurs on each side of the adductor muscle impressions. A relatively broad, pitted area surrounds the diductor muscle impressions laterally and anteriorly and extends to the edge of an interior raised rim about 3 mm wide that borders the lateral and anterior margins of the valve. Vascular impressions are not evident.

Comparison. *Desquamatia (Variatrypa) klukasi* n. sp. is distinguished from *Desquamatia (Variatrypa) clarkei* (Warren) by its more conspicuous and moderately developed growth lamellae bases. Relatively small, thick, rotund variants of the species are somewhat similar to *'Atrypa' gregeri* Rowley from the Devonian of Missouri.

Occurrence. *Desquamatia (Variatrypa) klukasi* n. sp. occurs abundantly in the Peace Point Member of the Waterways Formation, western Gypsum Cliffs area, Peace River, northern Alberta.

Figured specimens. Holotype GSC 57059 from GSC locality C-71460; paratype GSC 57053 from GSC locality C-71468; paratypes GSC 57054, 57056 and 57058 from GSC locality C-71460; and paratypes GSC 57052, 57057, 57060 and 57061 from GSC locality C-71463.

Genus *Pseudoatrypa* Copper, 1973

Type species. *Atrypa devoniana* Webster, 1921, p. 19 (not Pl. 8, figs. 9 - 11; see Fenton and Fenton, 1924, 1935).

Pseudoatrypa devoniana boyeri n. ssp.

Plate 5, figures 8 - 13, Plate 6, figures 44 - 47,
Plate 7, figures 1 - 25

Derivation of name. Subspecific name is after Charles Boyer, a North West Company trader on Peace River, referred to by Sir Alexander Mackenzie (see Craig, 1928, p. 24).

Material. Represented by 35 complete specimens.

Dimensions (mm)

Specimen	A	B	C	D
	Paratype	Paratype	Paratype	Holotype
GSC No.	57063	57064	57065	57066
GSC locality	C-71460	C-71451	C-71451	C-71451
Length of pv (Lpv)	13.8	21.2	20.7	24.9
Length of bv (Lbv)	13.2	20.3	19.9	23.6
Width (W)	16.8	22.0	22.0	27.7
Depth of shell (D)	7.5	10.6	10.6	12.1
Hinge line length	11.0	13.6	12.6	20.2
Hinge angle (in degrees)	152	153	153	159
Depth of sulcus at anterior margin	3.3	2.0	2.6	3.4
Ratio: W/Lpv	1.22	1.04	1.06	1.11
Ratio: D/Lpv	0.54	0.50	0.51	0.49

Specimen	E	F	G	H
	Paratype	Paratype	Paratype	Paratype
GSC No.	57067	57068	57069	57070
GSC locality	C-71460	C-71460	C-71465	C-71463
Length of pv (Lpv)	27.4	28.9	25.7	20.6
Length of bv (Lbv)	26.9	28.3	25.2	20.0
Width (W)	31.3	32.1	30.7	19.9
Depth of shell (D)	14.2	17.4	21.7	13.6
Hinge line length	17.6	22.0	23.0	14.5
Hinge angle (in degrees)	161	160	152	153
Depth of sulcus at anterior margin	6.7	6.7	ca. 8	5.1
Ratio: W/Lpv	1.14	1.11	1.19	0.97
Ratio: D/Lpv	0.52	0.60	0.84	0.66

Specimen	I	J
	Paratype	Paratype
GSC No.	57071	57040
GSC locality	C-71463	C-71466
Length of pv (Lpv)	25.0	10.4
Length of bv (Lbv)	24.9	10.0
Width (W)	23.4	10.7
Depth of shell (D)	14.8	4.4
Hinge line length	15.4	6.5
Hinge angle (in degrees)	146	150
Depth of sulcus at anterior margin	5.5	0
Ratio: W/Lpv	0.94	1.02
Ratio: D/Lpv	0.59	0.42

Description. Shell of small to medium size, highly variable in shape, varying from unequally biconvex to planoconvex in lateral profile; outline varies from subsemicircular, to subovate to elongate oval, generally wider than long, except for a few elongate oval forms which are longer than wide, greatest width at about one-quarter to one-half length from apex; posterolateral extremities rounded, lateral margins broadly rounded and gently convex ventrally; anterior commissure weakly and broadly uniplicate in young adult stages, moderately uniplicate in later stages.

Pedicle valve shallow, very gently arched to almost flat along the midline from back to front, highest at about one-quarter length from beak; lateral slopes flattened to concave. Sulcus is shallow and ill-defined in young stages, becoming slightly deeper and moderately to strongly upturned near the anterior margin to form a tongue in adult and senescent stages. Beak small, pointed, short. Interarea low, relatively wide, round-edged laterally, apsacline in young stages, becoming anacline and largely covered in later stages. Delthyrium with two wedge-shaped deltidial plates. Foramen relatively large, oval shaped, submesothyridid to mesothyridid.

Brachial valve a little more convex than the opposite valve in some young individuals, with increase in size the convexity increases to become four to six times as deep as the pedicle valve. Greatest height occurs at about one-third to one-half length from beak. Posterolateral slopes commonly extended, flattened, and concave in gerontic individuals. Lateral slopes flattened. Medial part of valve with an indistinct rounded fold that slightly widens anteriorly. Beak hidden by opposite valve.

Surface of both valves ornamented by medium, round-crested costae which increase in number anteriorly mainly by bifurcation, and much less commonly by implantation. They are separated by rounded troughs of about equal or greater widths. The increase in size of costae anteriorly is fairly pronounced in comparison with associated atrypids. Concentration of costae at 10 mm from the apex varies from 12 to 22 and averages 16 per 10 mm of arc; at 20 mm from the apex the concentration of costae varies from 11 to 16 and averages 13 per 10 mm of arc.

Concentric growth lamellae widely spaced in umbonal region, more closely spaced and commonly crowded toward the anterolateral margins. Frills inconspicuous, presumably short and fragile.

Microscopic growth lines, concentrated 9 to 19 and average 14 per mm, are evident only in the troughs separating costae of some specimens.

Discussion and comparison. Included in *Pseudoatrypa devoniana boyeri* n. ssp. are a variety of forms based on external shape and size but which are obviously closely related on such features as medium size of costae, weak development of lamellae, and other more subtle characters which easily distinguish this group from associated atrypids. Fenton and Fenton (1935, p. 382, 383), in redescribing the types of *Pseudoatrypa devoniana* of Webster (1921) and the variability they exhibited, arbitrarily subdivided the species into three groups based on shape and size differences, which they referred to informally as Forms A, B, and C. Stainbrook (1938, p. 240, 241) recognized three varieties of *Pseudoatrypa devoniana* (Webster) within the Rapid Member of the Cedar Valley Formation of Iowa which he named *tenuicosta*, *bentonensis* and *minor*. A small, thick, elongate form represented by paratypes GSC 57070 and 57071 of *Pseudoatrypa devoniana boyeri* n. ssp. is very closely similar in shape outline and size to *P. d.* var. *minor* of Stainbrook (1935, p. 240, 241, Pl. 32, figs. 17 - 26). The specimens from the Peace Point beds differ from the Cedar Valley form by having a broader and lower unisulcate anterior margin. Paratypes GSC 57070 and 57071 are also closely comparable to *'Atrypa' littletonensis* Stainbrook (1938, p. 238, Pl. 31, figs. 17, 21) and to *'Atrypa' bremerensis* Stainbrook (1938, p. 231, Pl. 31, figs. 11 - 14) from the Solon Member of the Cedar Valley Formation of Iowa. They differ from *'A.' littletonensis* by having a smaller, less extended pedicle beak and by having a much less sloping, almost straight cardinal margin. From *'A.' bremerensis*, paratypes GSC 57070 and 57071 differ in having a less pronounced fold on the brachial valve and in having a broader and lower unisulcate anterior margin.

Paratypes GSC 57064 and 57065 of *Pseudoatrypa devoniana boyeri* n. ssp. are somewhat similar to *Pseudoatrypa devoniana* var. *bentonensis* of Strainbrook (1938, p. 240, 241, Pl. 32, figs. 5 - 8) in subcircular outline and costation but differ from the Iowa form in having a straighter, less sinuous hinge line.

The form represented by paratypes GSC 57063, 57067, 57069, and holotype GSC 57066 of *Pseudoatrypa devoniana boyeri* n. ssp. is somewhat similar in semicircular outline and planoconvex lateral profile to *'A'. scutiformis* Stainbrook (1938, p. 234, Pl. 31, figs. 15, 16, 19, 20) from the *waterlooensis* Zone of the Rapid Member of the Cedar Valley Formation of Iowa. The form from the Peace Point beds is easily distinguished from the Iowa form by its coarser costae.

Occurrence. *Pseudoatrypa devoniana boyeri* n. ssp. is common in the lower part of the Peace Point Member of the Waterways Formation, western part of the Gypsum Cliffs area, Peace River, northern Alberta.

The species *Pseudoatrypa devoniana* (Webster) occurs typically in the Cerro Gordo Member (*Cyrtospirifer whitneyi* Zone) of the Lime Creek Formation of Iowa (Copper, 1973, p. 492) and is thus considerably younger than *P. d. boyeri* n. ssp. from the Peace Point Member.

The most closely comparable forms from Iowa include *'A.' bremerensis* Stainbrook and *'A'. littletonensis* Stainbrook from the *independensis* Zone and *profunda* beds, respectively, of the Solon Member; and *P. d.* var. *tenuicosta* Stainbrook from the *bellula* Zone, *P. d.* var. *bentonensis* Stainbrook and *P. d. minor* Stainbrook from

the *Pentamerella* beds, and '*A.*' *scutiformis* Stainbrook from the *waterlooensis* Zone of the Rapid Member of the Cedar Valley Formation. Conodonts in the lower Solon Member indicate assignment to the highest part of the *varcus* Zone, and conodonts in the Upper Solon - Lower Rapid members are assigned to the Lower *hermanni-cristatus* Subzone (Klapper et al., 1970, p. 298, Fig. 3). The Upper Rapid and Lower Coralville members are barren of conodonts but by stratigraphic position are probably assignable to the upper part of the *hermanni-cristatus* Zone because the succeeding Upper Coralville Member contains conodonts assignable to the *insita* fauna.

McCammon (1960, p. 51, 52, Pl. 8, figs. 10 - 12) recorded *Pseudoatrypa bremerensis* (Stainbrook) from the Dawson Bay Formation of southwestern Manitoba. More recent work on the Devonian of that area by Norris et al. (1982) indicates that this form is confined to Members B and C of the Dawson Bay Formation, which are within the conodont Middle *varcus* Subzone.

Figured specimens. Paratypes GSC 57063, 57067 and 57068 from GSC locality C-71460; paratypes GSC 57064, 57065 and holotype GSC 57066 from GSC locality C-71451; paratype GSC 57069 from GSC locality C-71465; paratypes GSC 57070 and 57071 from GSC locality C-71463; and paratype GSC 57040 from GSC locality C-71466.

Subfamily Palaferellinae Spriestersbach, 1942

(nom. transl. Struve, 1955, p. 211
(ex Palaferellidae Spriestersbach, 1942, p. 187))

Genus *Pseudogruenewaldtia* Rzhonsnitskaya, 1960

Type species. *Pseudogruenewaldtia tschernyschewi* (Rzhonsnitskaya), 1960b, p. 48, Pl. 1, fig. 7.

Pseudogruenewaldtia? sp.

Plate 6, figures 40 - 43

Material. Represented by a single complete specimen.

Dimensions (mm)

Specimen	A
GSC No.	57062
GSC locality	C-71465
Length of pv (Lpv)	23.3
Length of bv (Lbv)	21.9
Width (W)	23.0
Depth of shell (D)	14.0
Hinge line length	14.5
Hinge angle (in degrees)	145
Depth of sulcus at anterior margin	4.9
Ratio: W/Lpv	0.99
Ratio: D/Lpv	0.60

Description. Shell of medium size, slightly unequally biconvex in lateral profile, elongate oval-shaped, cardinal margin short, cardinal extremities forming an obtuse angle with the lateral margins, lateral margins broadly rounded, greatest width slightly anterior of midlength, anterior commissure moderately uniplicate.

Pedicle valve moderately and evenly arched from back to front along the midline, highest at about one-half length from beak, lateral slopes very gently convex. Sulcus is broad, shallow, flat-bottomed, ill-defined, and apparent only on the anterior medial quarter of the shell, where it is fairly strongly deflected dorsally to form a broad, short tongue. Beak conspicuous, slightly extended beyond opposite valve. Interarea low and relatively broad, round-edged laterally, slightly anacline. Delthyrium with two wedge-shaped deltidial plates which meet and appear to be fused along the midline. Foramen relatively large, mesothyridid, part of foramen penetrating deltidial plates is rounded and marked by a slightly raised rim, remainder of foramen is more angular and lacks rim.

Brachial valve is slightly more convex and thicker than opposite valve, highest at about one-third length from beak, posterolateral regions broadly rounded, flanks steep, very slightly convex to almost flat, fold is broad, flat-topped, evident only on the medial anterior third of valve. Beak is hidden by opposite valve.

Interior not evident.

Surface of both valves ornamented by radiating costae of medium strength which increase in number anteriorly mainly by bifurcation, much less commonly by implantation. Increase in size of costae anteriorly is very slight. Costae are separated by rounded troughs of equal or greater widths.

Concentration of costae at 10 mm from apex is 16 per 10 mm of arc, and at 20 mm from the apex it varies from 14 to 15 per 10 mm of arc.

Concentric growth lamellae bases of moderate strength, fairly widely spaced over most of shell, more closely spaced and crowded toward lateral and anterior margins. No frills preserved.

Microscopic markings include very fine closely spaced concentric growth lines and very fine closely spaced radiating lines preserved only in some troughs separating costae.

Comparison. On external features including oval outline, lateral profile, size of costae, shape and orientation of the pedicle beak, and shape of foramen, this form somewhat resembles *Pseudogruenewaldtia tschernyschewi* Rzhonsnitskaya (1964, p. 107, Pl. 2, figs. 6a - 6e) from the Vetlosyan Formation of Frasnian age outcropping along the Bol'shoi and Sed'yu rivers of Timan, and from the Kandinskaya Landing area of the Urals, U.S.S.R. It can be distinguished from the Russian form by its much shorter, less sloping hinge line, and by its thicker and more convex brachial valve.

Pseudogruenewaldtia? sp. from the Peace Point Member shows some morphologic affinity to *Gruenewaldtia gregeri* (Rowley) as described and illustrated by Greger (1936a, p. 94, 95, Pl. 1, figs. 1 - 13) which is recorded from a thin zone near the middle of the lower division of the Snyder Creek Shale of Callaway County, Missouri. Conodonts from the lower Snyder Creek Shale are assigned by Schumacher (in Klapper et al., 1970, Fig. 3) to the Middle *Polygnathus asymmetricus* Zone. Comparison with specimens in GSC collections from the Missouri locality (GSC loc. 6029) indicates that the Peace Point form attains a larger size at maturity, has slightly coarser costae, and the costae are crossed by weak lamellae, which are absent from *G. gregeri*. In lateral profile the Peace Point form is unequally biconvex with the brachial valve being more inflated than the pedicle valve; for *G. gregeri* the convexities of the two valves are almost equal, with the pedicle valve in some specimens being slightly more inflated. The unisulcate anterior margin of the Peace Point form is also much more pronounced than it is on *G. gregeri*.

The form designated as "*Atrypa gregeri* Rowley" by Maurin and Raasch (1972, Pl. 8, figs. 5 - 11), from roughly the upper half of the Flume Formation at Kakwa Lake and Wallbridge Mountain, east-central British Columbia, appears to more closely resemble *Gruenewaldtia gregeri* (Rowley) from the Snyder Creek Shale of Missouri than the *Pseudogruenewaldtia*? sp. from the Peace Point Member. A form closely resembling *G. gregeri* (Rowley) is known (Norris, 1963, Fig. 8) also from the Moberly Member of the Waterways Formation of northeastern Alberta.

Occurrence. *Pseudogruenewaldtia*? sp. is exceedingly scarce in the lower part of the Peace Point Member of the Waterways Formation, western part of the Gypsum Cliffs area, Peace River, northern Alberta.

Figured specimen. GSC 57062 from GSC locality C-71465.

Superfamily Cyrtinacea Frederiks, 1912

[nom. transl. Johnson, 1966 (ex Cyrtininae Frederiks, 1912]

Family Cyrtinidae Frederiks, 1912

Genus *Tecnocyrtina* Johnson and Norris, 1972

Type species. *Cyrtina billingsi* Meek, 1868

Tecnocyrtina billingsi (Meek)

Plate 7, figures 26 - 38

1868	*Cyrtina billingsi* Meek, p. 97, Pl. 14, figs. 6a - d.
1891b	*Cyrtina billingsi* Meek; Whiteaves, p. 227.
1944	*Cyrtina billingsi* Meek; Warren p. 129, Pl. 2, figs. 19 - 21.
1956	*Cyrtina billingsi* Meek; Warren and Stelck, Pl. 12, figs. 11 - 13.
1962	*Cyrtina billingsi* Meek; McLaren, Norris and McGregor, Pl. 10, figs. 21 - 23.
1972	*Tecnocyrtina billingsi* (Meek); Johnson and Norris, p. 566, Text-fig. 1, Pl. 1, fig 24, Pl. 2, figs. 1 - 14.

Material. Represented by 19 complete specimens, and 12 fragmentary specimens.

Dimensions (mm)

Specimen	A	B	C	D
GSC No.	57072	57073	57074	57075
GSC locality	C-71469	C-71465	C-71451	C-71451
Length of pv (Lpv)	16.8	12.4	12.8	14.3
Length of bv (Lbv)	11.4	10.0	9.7	-
Width (W)	14.9	11.5	13.6	15.4
Depth of shell (D)	9.3	7.7	9.5	8.5+
Hinge line length	12.4	9.4	10.4	11.2
Depth of sulcus at anterior margin	-	2.6	2.8	-
Ratio: W/Lpv	0.88	0.92	1.06	1.08
Ratio: D/Lpv	0.55	0.52	0.74	0.59

Description. Shell of small size at maturity.

The pedicle valve varies from strongly convex to subpyramidal. Hinge line is long and straight and is always less than maximum width. Cardinal angles are slightly rounded and obtuse. The ventral interarea is long, triangular-shaped, relatively straight to strongly curved, sharp-edged laterally, catacline to apsacline, and where curved the apical parts of the interarea may be orthocline or even anacline. Interarea is marked by closely spaced parallel growth lines parallel to the hinge line and which continue across the deltidium. Interarea is also marked by very fine microscopic lines, which are perpendicular to the growth lines and which are also present on the deltidium. The delthyrium is long, narrow, and triangular, enclosing an angle of about 20 degrees. It is covered along roughly its basal half by a moderately convex deltidium. The pedicle beak varies from straight to variably incurved, and in some specimens it is irregularly twisted to one side. The pedicle valve of some specimens has a very shallow, broad U- to V-shaped sulcus; in other specimens the sulcus is barely perceptible and is generally marked by a faint narrow indentation. Where the sulcus is present, it is commonly extended as a short tongue into the brachial valve and delineated laterally by relatively strong costae.

The brachial valve is subsemicircular in outline, and very gently convex in lateral profile. In some larger specimens there is a sharp reversal of curvature of the valve, which is concentric to the lateral and anterior margins of the shell and presumably delineates the body cavity of the shell. The beak is small and inconspicuous and is generally covered by the opposite valve. The brachial valve of some specimens bears a low, flat-topped, trumpet-shaped fold, which is delineated laterally by relatively deep troughs which are wider than the troughs separating the costae. Other specimens are without folds on the brachial valves.

Both valves are ornamented with relatively coarse radiating costae, which increase in number anteriorly by bifurcation and implantation. The costae are round-crested and separated by rounded troughs of equal or greater width than the costae. Around the anterior margins of the flanks of the pedicle valve the costae vary in number from 7 to 15; at the anterior margin of the sulcus they vary from 5 to 10; on the flanks of the brachial valve they vary from 9 to 15; and on the fold of the brachial valve they vary from 9 to 11. The bases of concentric growth lamellae record intervals of relatively wide spacing and rapid growth and close spacing suggestive of slow growth. Present between the growth lamellae are very fine microscopic concentric markings. Traces of very fine closely spaced microscopic radiating markings can be seen also in some of the troughs separating the costae.

The interiors of both valves are moderately crenulated by the impress of the costae. Exfoliated surfaces show under magnification the minutely punctate structure characteristic of some cyrtinids.

The interior of *Tecnocyrtina billingsi* (Meek) is well illustrated by Johnson and Norris (1972, Text-fig. 1, Pl. 2, figs. 15 - 19) and includes material from the Peace Point Member of the Waterways Formation of the Gypsum Cliffs area.

Comparison. *Tecnocyrtina billingsi* (Meek) is distinguished from the slightly older species, *T. missouriensis* (Swallow), as illustrated by Johnson (in Johnson and Norris, 1972, Pl. 1, figs. 15 - 18) from the Callaway Formation, Bellamy Springs, Callaway Co., Missouri, by its more numerous and finer costae and by its less pronounced fold and sulcus.

From the approximately contemporaneous species, *T. beckmanni*, described by Johnson (1973) from the "Flinz" of the lower Upper Devonian of Sauerland, West Germany, *T. billingsi* is distinguished by the presence of a low, flat, dorsal fold in contrast to the complete absence of a dorsal fold on *T. beckmanni*. The latter species is also distinguished by a narrow median furrow on the ventral valve and a relatively deep ventral valve.

Discussion. An internal structure that may be unique in the genus *Tecnocyrtina* is the presence of a strut that extends beyond the tichorhinum to form a septum-like structure along the midline between the dental plates. This structure is present in *Tecnocyrtina missouriensis* (Swallow) and *Tecnocyrtina billingsi* (Meek) (Johnson and Norris, 1972), and in *Tecnocyrtina beckmanni* Johnson (1973). This feature has not been seen in species of *Cyrtina* from older Devonian beds in western and northwestern Canada.

The question of whether or not the variability of external form observed in specimens of *Tecnocyrtina billingsi* (Meek) is sufficiently distinct and consistent to warrant subdivision into subspecies will have to await further study of larger collections.

Occurrence. *Tecnocyrtina billingsi* (Meek) is moderately abundant in the Peace Point Member of the Waterways Formation, western part of the Gypsum Cliffs area, Peace River, Alberta. Along the Clearwater and Athabasca rivers of northern Alberta this form ranges through the Firebag, Calumet and Christina members and into the lower part of the Moberly Member of the Waterways Formation. In terms of conodont chronology of Uyeno (1974, p. 5, Table 1), this range spans the *Pandorinellina insita* fauna to roughly the lower third of the Middle *Polygnathus asymmetricus* Zone.

The distribution of *Tecnocyrtina billingsi* in western and northwestern Canada outside of northern Alberta includes: the Fernie area of southern British Columbia; basal Devonian beds at Kakwa and Cecilia Lakes in east-central British Columbia; lower Upper Devonian beds on the upper reaches of Sikanni Chief River, northeastern British Columbia; the lower part of the Hay River Formation on the northwest and south sides of Great Slave Lake, southern District of Mackenzie; and unnamed lower Frasnian beds on Powell Creek, central Mackenzie River area, District of Mackenzie.

Maurin and Raasch (1972, Pls. 1, 3) recorded "*Cyrtina billingsi* Meek" from the uppermost part of their assemblage III and from the lower half of their assemblage IV in the Flume Formation at northern Kakwa Lake, east-central British Columbia. Judging from their plotted section, *T. billingsi* ranges from about 44.3 m to about 56.9 m above the base of the Flume Formation where the formation is about 96.9 m thick.

Johnson (in Johnson and Norris, 1972, p. 570, 571) reported "*Cyrtina* cf. *C. billingsi* Meek" in the lower Jefferson Formation of the central Blue Hills in northern Utah, and has illustrated a specimen of *Tecnocyrtina* aff. *T. billingsi* (Meek) from the basal unit of the Devils Gate Limestone of northern Simpson Park Range in central Nevada. The latter occurrence along with associated fossils are discussed in more detail by Johnson (1978, p. 121).

Figured specimens. GSC 57072 from GSC locality C-71469; GSC 57073 from GSC locality C-71465; and GSC 57074 and 57075 from GSC locality C-71451.

Superfamily Spiriferacea King, 1846

(nom. transl. Schuchert, 1896, p. 33
(ex Spiriferidae King, 1846, p. 28))

Family Delthyridae Waagen, 1883

(nom. correct. Pitrat, in Moore, 1965
(pro Delthyridae Waagen, 1883, nom. transl. Ivanova, 1959, p. 56, ex Delthyrinae Waagen, 1883, p. 507))

Subfamily Acrospiriferinae Termier and Termier, 1949

Genus *Eleutherokomma* Crickmay, 1950

Type species. *Eleutherokomma hamiltoni* Crickmay, 1950, p. 219, Pl. 36, figs. 1 - 3

Eleutherokomma impennis Crickmay, 1953

Plate 7, figures 39 - 48, Plate 8, figures 1 - 4

1953 *Eleutherokomma impennis* Crickmay, p. 3, Pl. 2, figs. 1 - 8.
1956 *Eleutherokomma* n. sp., Warren and Stelck, Pl. 120, figs. 2 - 4.
1962 *Eleutherokomma impennis* Crickmay; McLaren, Norris and McGregor, Pl. 10, figs. 18 - 20.
1963 *Eleutherokomma aechmophora* Crickmay, p. 16, Pl. 3, figs. 14, 15, Pl. 11, figs. 9 - 13.
1971 *Eleutherokomma* sp. cf. *E. impennis* Crickmay; Harrington, p. 792, Pl. 4, figs. 12 - 16 (not Pl. 4, figs. 1 - 10).

Material. Represented by 2 complete specimens and 11 fragmentary specimens.

Dimensions (mm)

Specimen	A	B	C	D
GSC No.	57076	57077	57078	57079
GSC locality	C-71463	C-71469	C-71469	C-71451
Length of pv (Lpv)	10.7	7.3	11.0	-
Length of bv (Lbv)	10.0	8.1	-	10.6
Width (W)	15.4	11.2	20.0	17.0
Depth of shell (D)	7.4	6.0	-	-
Hinge line length	14.6	10.1	ca. 20	ca. 17
Depth of sulcus at anterior margin	1.8	0.7	1.6	-
Ratio: W/Lpv	1.44	1.53	1.81	-
Ratio: D/Lpv	0.69	0.82	-	-

	Holotype of *E. impennis*	Holotype of *E. aechmophora*
Length of pv (Lpv)	7	12
Length of bv (Lbv)	-	-
Width (W)	13	21.5
Depth of shell (D)	3 (bv)	8.5
Hinge line length	-	-
Depth of sulcus at anterior margin	-	-
Ratio: W/Lpv	1.86	1.79
Ratio: D/Lpv	-	0.71

Description. Shell small at maturity, subequally biconvex, subsemicircular, cardinal extremities acute, commonly very slightly extended but not mucronate, broadly rounded anterolateral margins, considerably wider than long with the greatest width at the hinge line, anterior commissure uniplicate and indented.

Pedicle valve subpyramidal, relatively high but only moderately convex, in young specimens highest at beak, in adult specimens highest at about one-quarter to one-third length from beak. The sulcus is narrow over the umbo, becoming wide at anterior margin, moderately shallow, U-shaped, bordered by costae slightly coarser than those on flanks, sulcus is continued slightly at the front to form a short tongue. Flanks moderately convex from back to front, sloping steeply and gently convex from sulcus to lateral margins, flat to gently concave toward the posterolateral extremities. Beak is high, sharp, slightly inturned near apex, positioned slightly anterior of hinge line in young stages and extending posterior of hinge line in adult stages. Interarea is broad, relatively high, bordered laterally by very sharp slightly raised ridges, catacline in young stages, becoming apsacline in later stages. Delthyrium is open, and encloses an angle of about 23 degrees. Dental plates are evident along the edges of the delthyrium.

Brachial valve is less high and slightly less convex than the pedicle valve; highest at about one-third to one-half length from beak. Flanks are gently convex to almost flat toward lateral margins, gently concave toward hinge line and posterolateral extremities. Fold is strong but little elevated, broadly U-shaped, extending from beak to anterior margin, bordered laterally by wider and deeper troughs than those on flanks. Fold in some specimens is slightly indented along the midline by a shallow trough. Beak is small, slightly extended beyond hinge line and slightly incurved. Interarea is broad, very low, approximately orthocline.

Flanks are ornamented with relatively coarse, rounded costae which increase in strength anteriorly and, where present, increase in number by bifurcation. Number of costae along the anterior-lateral margins of the flanks vary from 8 to 10; they are absent from the fold and sulcus. Growth lamellae are fairly coarse, closely and irregularly spaced, 3 to 5 occurring in a space of 1 mm on both valves. Between successive growth lamellae there are 8 to 10 faint microscopic concentric markings. The surface of the shell is covered with very fine, microscopic radial striae, about 14 occurring in a space of 1 mm of arc. The interareas of both valves are marked with very fine closely spaced transverse and longitudinal markings.

Discussion and comparison. In the descriptions of *Eleutherokomma impennis* Crickmay (1953) and *Eleutherokomma aechmophora* Crickmay (1963), no statements were made by him concerning a comparison or differentiation of these two species. Although the types are from different localities, from the Bear Westmount No. 2 well near Fort McMurray and Gypsum Cliffs, respectively, both species are from approximately equivalent beds in the Firebag Member of the Waterways Formation. Judging from Crickmay's (1953, 1963) descriptions and illustrations, the writer (AWN) considers *E. aechmophora* to be a junior synonym of *E. impennis*.

Some of the more characteristic features of *E. impennis* are its relatively small size, a lack of development of extended posterolateral extremities characteristic of later species, and a relatively simple ornament.

Eleutherokomma impennis as here interpreted can be easily differentiated from the older *E. implana* Norris (in McLaren and Norris, 1964, p. 59, Pl. 16, figs. 17a - 19, Pl. 17, figs. 1a - 3e). The latter form occurs in the Horn Plateau Formation northwest of Great Slave Lake where it is associated with conodonts assigned by T.T. Uyeno to the Middle *Polygnathus varcus* Subzone. Compared with *E. implana* Norris, *E. impennis* Crickmay has finer and more even costae on the flanks, it has a U-shaped rather than a V-shaped sulcus on the pedicle valve, and it has a higher and straighter pedicle interarea.

Eleutherokomma impennis is distinguished from its succeeding most nearly comparable form *E. jasperensis* (Warren), by its lack of or very weak development of posterolateral extremities, which are acute and moderately extended on the latter form.

Occurrence. *Eleutherokomma impennis* Crickmay occurs sparsely in beds of the Peace Point Member of the Waterways Formation, western part of the Gypsum Cliffs area, Peace River, Alberta. The type specimens of this form according to Crickmay (1953, p. 3) are from 103.9 - 107.3 m in the Bear Westmount No. 2 well located at 8-36-88-8-W4M on the south bank of Clearwater River about 16 km east-southeast of Fort McMurray, Alberta. This interval is within 14.3 - 17.7 m of the base of the Firebag Member of the Waterways Formation where the member is 55.8 m thick (see Norris, 1973, Figs. 4, 5).

The type specimens of *E. aechmophora* Crickmay (1963, p. 16, Pl. 3, figs. 14 - 15, Pl. 11, figs. 9 - 13), here placed in synonymy with *E. impennis*, are from shale beds of the Peace Point Member of the Waterways Formation, Gypsum Cliffs, Peace River, Alberta. From evidence of slumped shale beds filling sinkholes and widened joint fissures, it is highly likely that the types are from beds representative of roughly the basal 6.1 m of the Peace Point Member which correlate with the basal beds of the Firebag Member of the Waterways Formation in the Clearwater and Athabasca rivers area.

From this comparison of the stratigraphic intervals of the types of *E. impennis* and *E. aechmophora*, it appears that *E. impennis* occurs very slightly higher.

In a later publication, Crickmay (1966, p. 20) recorded the presence of *E. impennis* from between 460.8 - 493.8 m, which is within the upper 32.9 m of the Firebag Member in the Bear Biltmore No. 1 well (7-11-87-17-W4M) where the thickness of the member is recorded as 51.8 m. From core of the same well, Crickmay (1966) recorded *E.* sp. cf. *E. impennis* and *E.* sp. cf. *E. aechmophora* from 429.8 - 460.8 m, an interval 31.1 m thick assigned to the Calumet Member. From succeeding beds in the same well, Crickmay (1953, p. 20) recorded *E.* sp. cf. *E. aechmophora* from 402.3 - 429.8 m, an interval 27.4 m thick assigned to the Christina Member. From core of the Bear Rodeo No. 1 well (lot 5, McMurray Settlement, 89-9-W4M), Crickmay (1966, p. 21) recorded *E. impennis* from 121.9 - 130.5 m, an interval 8.5 m thick, 16.7 - 25.3 m above the base of the Firebag Member.

Some of the specimens illustrated as *Eleutherokomma* sp. cf. *E. impennis* Crickmay by Harrington (1971, p. 792, 793, Pl. 4, figs. 1 - 10, 12 - 16) from the Weatherall Formation on Banks Island, Northwest Territories, probably should be assigned to the genus *Cyrtospirifer*. The specimen (UC6614, K-69-11) illustrated by Harrington (1971, Pl. 4, figs. 12 - 16) which may be assigned to *E. impennis* is recorded from 70.7 m above the base of the Weatherall Formation where the formation is about 792.5 m thick.

Figured specimens. GSC 57076 from GSC locality C-71463; GSC 57077 and 57078 from GSC locality C-71469; and GSC 57079 from GSC locality C-14151.

Conodonta

Family Polygnathidae Bassler, 1925

Type genus. *Polygnathus* Hinde, 1879

Genus *Pandorinellina* Müller and Müller, 1957

Type species. *Pandorina insita* Stauffer, 1940

Pandorinellina insita (Stauffer)

Plate 1, figures 35 - 39

1940	***Pandorina insita*** Stauffer, p. 429, Pl. 59, figs. 23, 25 (Pa).
1977	***Pandorinellina insita*** (Stauffer); Klapper, in Ziegler, 1977, p. 437 - 439, ***Pandorinellina*** Pl. 1, figs. 1 - 8 (multielement) (includes synonymy).
in press	***Pandorinellina insita*** (Stauffer); Uyeno, in Norris et al., Pl. 38, figs. 25 - 45 (multielement).

Remarks. Sandberg and Poole (1977) have regarded *Pandorinellina insita* as characteristic of shallow-water biofacies which is equivalent to the interval of Lowermost to Upper *Polygnathus asymmetricus* Zones.

Occurrences. In northeastern and central Alberta, *Pandorinellina insita* ranges from Firebag through Moberly members of the Waterways Formation (Uyeno, 1974, Table 1). In southern Manitoba it occurs in the Micritic limestone beds of Point Wilkins Member and the Sagemace Member of the Souris River Formation. *Pandorinellina insita* has been found in an undescribed collection from the type Starbird Formation in southeastern British Columbia (GSC loc. C-60937). The Starbird Formation at its type section at Mount Forster is 17.1 m thick, according to B.S. Norford (pers. com., 1977). The upper 9.1 m have yielded a brachiopod fauna containing *Eleutherokomma* and species of *Productella*, *Schizophoria* and *Atrypa*, which strongly suggests an early Late Devonian age (McLaren, 1962, p. 3). The lower part of the Starbird is unfossiliferous. See Klapper (in Ziegler, 1977, p. 438, 439) for regional occurrences of *P. insita*.

Range. According to Klapper (in Ziegler, 1977, p. 438), *Pandorinellina insita* ranges from the Middle-Upper Devonian boundary beds to lower Upper Devonian. Schumacher (1976, Fig. 1) has indicated the first occurrence of *P. insita* in beds equivalent to the Upper *hermanni-cristatus* Zone in the Cedar Valley Formation of central Missouri.

Figured specimens. GSC 58247 to 58249 from GSC locality C-71467; and GSC 58250 from GSC locality C-45977.

Pandorinellina cf. *P. insita* (Stauffer)

Plate 1, figures 31 - 34

1967	***Spathognathodus***? sp.; Uyeno, p. 11, Pl. 2, figs. 2, 3 (Pa).
1974	***Spathognathodus***? sp.; Uyeno, p. 44, Pl. 8, figs. 8, 10, (Pa).
1975	***Spathognathodus insitus*** (Stauffer) → ***Ancyrodella rotundiloba binodosa*** Uyeno; Bultynck, p. 17, 25 (Pa).

Remarks. The peculiar spathognathodontan element is similar to that of ***Pandorinellina insita*** except in its possession of accessory denticles on either side of the blade. It has been regarded as morphologically transitional between ***Pandorinellina insita*** and ***Ancyrodella rotundiloba binodosa*** Uyeno (Uyeno, 1967, p. 11; 1974, p. 44; Klapper et al., 1970, p. 300, 301; Bultynck, 1975, p. 17, 25). The stratigraphic significance of ***Pandorinellina*** cf. ***P. insita*** is discussed under the heading "Biostratigraphy".

Figured specimens. GSC 58245 and 58246 from GSC locality C-71467.

Genus *Polygnathus* Hinde, 1879

Type species. *Polygnathus dubius* Hinde, 1879

Polygnathus brevilaminus Branson and Mehl

Plate 1, figures 1 - 8

1934	***Polygnathus brevilamina*** Branson and Mehl, p. 246, Pl. 21, figs. 3 - 6 (Pa).
1974	***Polygnathus brevilaminus*** Branson and Mehl; Uyeno, p. 37, 38, Pl. 5, figs. 4 - 5 (Pa) (includes synonymy).
1976	***Polygnathus brevilaminus*** Branson and Mehl; Druce, p. 183, 184, Pl. 70, figs. 3 - 5 (Pa).
in press	***Polygnathus brevilaminus*** Branson and Mehl; Uyeno, in Norris et al., P. 37, figs. 1 - 14 (multielement).

Remarks. The apparatus of *Polygnathus brevilaminus* was illustrated and discussed by Uyeno (in Norris et al., in press), based on a reconstruction from collections originating in the Point Wilkins Member of the Souris River Formation of southwestern Manitoba. An almost complete apparatus of this species was recorded from the Slave Point Formation in the present study; only the diplododellan Sa element is absent.

The Pa element of *Polygnathus brevilaminus* in the present Slave Point material differs somewhat from that originating in the Firebag Member of the Waterways Formation of Alberta, and the Souris River Formation of Manitoba, in being consistently smaller. The remaining constituent elements are of "normal" size, however. The platform margins in the Slave Point Pa element are also slightly biconvex, as opposed to parallel. The pit is located at the junction of the platform and the free blade, whereas, in the Waterways and Souris River specimens, the pit is halfway between the midlength and the anterior end of the platform. As discussed by Uyeno (in Norris et al., in press), the concept of *Polygnathus brevilaminus* is rather broad in the sense of Anderson and Ozias (1968) and would include the Slave Point specimens.

Occurrences. See Uyeno (in Norris et al., in press). The range is from possible Upper *varcus* Subzone to doV.

In the Waterways Formation, *Polygnathus brevilaminus* ranges from the Firebag through Moberly members (Uyeno, 1974, Table 1), and in southwestern Manitoba the species occurs in the "First Red" and the Argillaceous limestone beds of the Point Wilkins Member of the Souris River Formation (Uyeno, in Norris et al., in press, Table 13).

Figured specimens. GSC 58227 to 58232 from GSC locality C-71457.

Polygnathus cf. *P. dubius* Hinde

Plate 1, figures 40 - 44

1970	(cf.) ***Polygnathus dubius*** Hinde; Huddle, p. 1037, Pl. 138, figs. 1 - 17 (Pa).
1973	(cf.) ***Polygnathus dubius*** Hinde; Klapper, in Ziegler, p. 353 - 354, ***Polygnathus*** Pl. 1, figs. P, O_1, N, A_{1-3} (multielement).
in press	***Polygnathus*** cf. ***P. dubius*** Hinde; Uyeno, in Norris et al., Pl. 36, figs. 31 - 33 (Pa).

Remarks. The Peace Point specimens referred to *Polygnathus* cf. *P. dubius* are similar to that illustrated by Uyeno (in Norris et al., in press) from the Souris River Formation of southwestern Manitoba. They are also similar to those from the Genundewa Limestone Member of the Genesee Formation, New York, which were illustrated by Huddle (1970, Pl. 138, figs. 12, 17).

Occurrence. In southwestern Manitoba, *Polygnathus* cf. *P. dubius* occurs in the Micritic limestone beds, Point Wilkins Member, Souris River Formation.

Figured specimens. GSC 58251 and 58252 from GSC locality C-71464.

Polygnathus cf. *P. pennatus* Hinde

Plate 1, figures 45, 46

1879 (cf.) *Polygnathus pennatus* Hinde, p. 366, Pl. 17, fig. 8 (Pa).
1973 (cf.) *Polygnathus pennatus* Hinde; Klapper, in Ziegler, p. 373, 374, *Polygnathus* Pl. 1, fig. 7 (Pa).

Remarks. The single Peace Point specimen is only compared with *Polygnathus pennatus* as it differs in the following features: (i) the platform outline is oval rather than elongated and lanceolate; and (ii) the anterior margins of the platform meet the free blade at acute angles, rather than at, more or less, right angles. The latter feature is, however, variable (for example, see Huddle, 1970, Pl. 137, figs. 12, 16).

Figured specimen. GSC 58253 from GSC locality C-71467.

Polygnathus webbi Stauffer

Plate 1, figures 47, 48

1938 *Polygnathus webbi* Stauffer, p. 439, Pl. 53, figs. 25, 26, 28, 29 (Pa).
1973 *Polygnathus webbi* Stauffer; Klapper, in Ziegler, p. 393, 394, *Polygnathus* Pl. 2, fig. 7 (Pa) (includes synonymy).
1974 *Polygnathus webbi* Stauffer; Uyeno, p. 40, Pl. 5, fig. 7 (Pa).

Occurrences. In northeastern and central Alberta, *Polygnathus webbi* occurs in the Firebag through Moberly members of the Waterways Formation (Uyeno, 1974, Table 1). The range cited by Klapper (in Ziegler, 1973, p. 394) requires a downward extension, to the *insita* fauna (Lowermost *asymmetricus* Zone). The revised range of this species is the *insita* fauna to the *velifer* Zone.

Figured specimen. GSC 58254 from GSC locality C-71467.

Family Icriodontidae Müller and Müller, 1957

Type genus. *Icriodus* Branson and Mehl, 1938

Genus *Icriodus* Branson and Mehl, 1938

Type species. *Icriodus expansus* Branson and Mehl, 1938

Icriodus subterminus Youngquist

Plate 1, figures 9 - 22, 25 - 27

1947 *Icriodus subterminus* Youngquist, p. 103, Pl. 25, fig. 14 (I).
1974 *Icriodus brevis brevis* Stauffer; Uyeno, p. 29, 30, Pl. 6, figs. 11, 12 (I), not fig. 3 (= *I. expansus*?).
1975 *Icriodus subterminus* Youngquist; Klapper, in Ziegler, p. 149, 150, *Icriodus* Pl. 3, fig. 4 (I) (includes synonymy).
1976 *Icriodus brevis brevis* Stauffer; Druce, p. 112, Pl. 32, figs. 1, 2 (I).
in press *Icriodus subterminus* Youngquist; Uyeno, in Norris et al., Pl. 36, figs. 16 - 22, Pl. 37, figs. 15 - 21 (multielement).

Remarks. A set of three simple cones has been assigned to the apparatus of *Icriodus subterminus*, and the elements have been designated as S_2a, S_2b, and S_2c. In a previous reconstruction based on material from the Souris River Formation of southern Manitoba, only the S_2b element was found (Uyeno, in Norris et al., in press). The simple cone elements are identical with those of *Icriodus brevis* Stauffer, the apparatus of which was reconstructed and discussed by Uyeno (in Norris et al., in press, Pl. 33, figs. 25 - 28) from collections originating in the Dawson Bay Formation of southwestern Manitoba.

The I elements of *Icriodus subterminus* obtained from the Slave Point Formation are notable for two reasons: (i) they are consistently smaller than those from the overlying Peace Point Member, although the accompanying simple cone elements are of "normal" size (and in this regard are comparable with relative sizes of the Pa and its accompanying constituent elements of *Polygnathus brevilaminus*, also from the same sample); and (ii) the posterior extension of the middle row is markedly bent inward.

Figured specimens. GSC 58233 to 58239 from GSC locality C-71457; GSC 58240 from GSC locality C-71464; GSC 58241 from GSC locality 45977; and GSC 58242 from GSC locality C-71467.

Icriodus cf. *I. subterminus* Youngquist

Plate 1, figures 23, 24, 28 - 30

1972 *Icriodus nodosus* (Huddle) s.l.; Uyeno, in Norris and Uyeno, p. 219, Pl. 3, fig. 18 (I).
in press *Icriodus* cf. *I. subterminus* Youngquist; Uyeno, in Norris et al., Pl. 37, figs. 22 - 27, Pl. 38, figs. 8 - 10, 16 - 21 (I).

Remarks. The Peace Point I elements of *Icriodus* cf. *I. subterminus* may have elongated denticles in the middle row (Pl. 1, fig. 23) or the lateral rows (Pl. 1, fig. 28). This feature is in contrast with the round, peglike denticles in those specimens from the Point Wilkins Member, Souris River Formation of southwestern Manitoba (Uyeno, in Norris et al., in press, Pl. 37, figs. 22, 25, Pl. 38, figs. 8, 16, 19). In common with the Souris River specimens, the Peace Point I elements have (i) a basal cavity with an anteriorly directed spur and accompanying sinus, similar to *Icriodus difficilis* Ziegler and Klapper; (ii) the posterior extension of the middle row that is about the same height as the platform denticles; and (iii) at least in some specimens, a low ridge on the upper surface of the spur.

Figured specimens. GSC 58243 from GSC locality C-71464; and GSC 58244 from GSC locality C-71467.

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Appendix

DESCRIBED STRATIGRAPHIC SECTIONS

SECTION 1. Parts of the Slave Point Formation and Peace Point Member of the Waterways Formation exposed at Station 1NB (59°11'00"N, 112°41'25"W) on the north bank of Peace River opposite the midpoint of an unnamed island near the lower end of Boyer Rapids, Gypsum Cliffs, northern Alberta. Measured by A.W. Norris and A.E.H. Pedder, June 7, 1977. Measurements are in metres.

UPPER DEVONIAN
Waterways Formation
Peace Point Member — 0 - 6.1 m, incomplete

MIDDLE DEVONIAN
Slave Point Formation — 18.73 m, incomplete

Unit	Lithology	Thickness	Height Above Base
	UPPER DEVONIAN		
	WATERWAYS FORMATION		
	Peace Point Member		
	(0 - 6.1 m, incomplete)		
10	Shale, variably calcareous, greenish grey, with scattered thin beds of limestone coquina, argillaceous, greenish grey, containing abundant macerated fossils. These beds occupy widened joint fissures and sinkholes in beds of the Slave Point Formation. Sample 1NBa (GSC loc. C-71451) - fossils collected loose which have been derived from slumped shale and limestone beds filling a sinkhole: *Schizophoria lata* Stainbrook *Ladogioides pax* McLaren *Desquamatia (Independatrypa) independensis* (Webster) *Desquamatia (Variatrypa) clarkei* (Warren) *Desquamatia (Variatrypa) klukasi* n. sp. *Pseudoatrypa devoniana boyeri* n. ssp. *Tecnocyrtina billingsi* (Meek) *Eleutherokomma impennis* Crickmay	0 - 6.1	
	MIDDLE DEVONIAN		
	SLAVE POINT FORMATION		
	(18.73 m, incomplete)		
9	Limestone, calcarenite, in part pelletoid, medium brown, fine grained, thick bedded to massive, weathers orange-brown; noted one worn atrypid fragment. Unit 9 is exposed near the top of the river bank where it is unconformably overlain by Pleistocene and Recent deposits. Sample 1NBi (GSC loc. C-71459) - for conodonts collected from 0.1 to 0.2 m below top of unit 9	1.7	18.73
8	Poorly exposed interval of limestone, weathering orange-brown, lenticular medium bedded, becoming more thinly bedded and more fissile eastward	ca.2	17.03

Unit	Lithology	Thickness	Height Above Base
7	Limestone, calcarenite, faintly colour banded, light to medium brown, fine to medium grained, massive in lower 0.6 m of unit, cliff forming, weathers pale orange, becomes more thinly bedded eastward and upward in unit; contains scattered fragments of *Amphipora*? sp.		
	Sample 1NBh (GSC loc. C-71458) - for conodonts taken from 0.60 to 0.65 m above base of unit 7	1.0	15.03
	Bedding 127T/32W at west edge of outcrop on east edge of a large sinkhole containing slumped beds of the Peace Point Member.		
6	Limestone, calcarenite, colour banded, medium brown and light, very fine grained, thinly bedded, fissile, weathers pale brown, less resistant than units above and below; tiny poorly preserved tentaculitids concentrated along some bedding planes.		
	Sample 1NBg (GSC loc. C-71457) - for conodonts taken 0.4 to 0.5 m below top of unit 6	1.8	14.03
5	Limestone, calcarenite, light to medium brown, fine grained, beds 0.1 to 0.45 m thick, weathers pale orange and cream orange, unit highly resistant; contains scattered finely disseminated iron sulphide.		
	Sample 1BNf (GSC loc. C-71456) - for conodonts taken from 0 to 0.1 m above base of unit 5	3.15	12.23
4	Shale, bituminous, contains detrital calcareous grains, laminated medium to dark brownish grey, recessive, contains sparse scattered medium brown calcareous nodules, abundant poorly preserved minute *Tentaculites* sp. concentrated in some laminae.		
	Sample 1NBe (GSC loc. C-71455) - for conodonts and spores	0.08	9.08
3a	Limestone, detrital and micritic, brecciated, medium brown, medium and fine grained, weathers medium brownish grey; abundant fine scattered sparry calcite.		
	Sample 1NBd (GSC loc. C-71454) - for conodonts taken 0.6 to 0.7 m below top of unit	2.1	9.0
3	Limestone, micritic, light to medium orange-brown, fine grained, weathers light brown, in places beds contain brecciated angular fragments of a lighter coloured limestone, bedding varies from massive, to highly contorted, to thinly bedded and fissile, unit is highly resistant; some brecciated fragments are minutely vuggy, others contain fine scattered iron sulphide.		
	Sample 1NBc (GSC loc. C-71453) - for conodonts taken from 0 to 0.1 m above base of unit	0.9	6.9
2	Limestone, micritic, in part slightly argillaceous, colour laminated light to medium brown, micritic to fine grained, thinly bedded, fissile, weathers light cream-brown; scattered fine carbonized plant tissue on some bedding planes.		
	Sample 1NBb (GSC loc. C-71452) - for conodonts taken from 0 to 0.1 m above base of unit	3.1	6.0
1	Covered interval from river level to base of unit 2, measured at the axis of a small anticline	2.9	2.9

SECTION 2. Parts of the Slave Point Formation and Peace Point Member of the Waterways Formation exposed at Station 261NB (59°09'20"N, 112°42'06"W) along the west bank of Peace River at water's edge, 2.7 km above the upper end of Boyer Rapids, Gypsum Cliffs, northern Alberta. Beds measured from south to north across the south limb of a synclinal fold where the bedding attitude varies from 108T/37N to 100T/25N. The same succession of beds can be seen on the north limb of syncline at Station 262NB (59°09'21"N, 112°42'05"W). Measured by A.W. Norris and P.A. Bolton, August 7, 1961. Measurements are in metres.

UPPER DEVONIAN
Waterways Formation
Peace Point Member — ca. 0.3 m, incomplete

MIDDLE DEVONIAN
Slave Point Formation — 14.8 m, incomplete

Unit	Lithology	Thickness	Height Above Base
	UPPER DEVONIAN		
	WATERWAYS FORMATION		
	Peace Point Member		
	(ca. 0.3 m, incomplete)		
11	Limestone, highly argillaceous, light greenish grey, fine grained, rubbly thin bedded, weathers medium greenish grey, contains numerous macerated brachiopod fragments.		
	The contact between unit 11 and underlying beds is obscured and unit 11 may represent a large loose block.		
	Sample 261NBd (GSC loc. 46360) - fossils from unit 11:		
	Schizophoria lata Stainbrook *Desquamatia (Variatrypa) clarkei* (Warren) *Tecnocyrtina billingsi* (Meek) echinoderm ossicle with single axial canal undet. planispiral gastropod fragment		
	Sample 261NBe (GSC loc. 45977) - fossils collected in loose fragments consisting of limestone, brachiopod coquina, argillaceous, light greenish grey, rubbly thin bedded, weathers pale orange-brown and light greenish grey, contains closely packed macerated skeletal fragments:		
	Aulopora sp. *Spirorbis* sp. *Schizophoria lata* Stainbrook *Desquamatia (Variatrypa) clarkei* (Warren) *Pseudoatrypa devoniana boyeri* n. ssp. *Ladogioides pax* (McLaren) *Eleutherokomma impennis* Crickmay *Tecnocyrtina billingsi* (Meek) echinoderm ossicle with single axial canal	ca. 0.3	15.1
10	Covered interval	0.06	14.8

Unit	Lithology	Thickness	Height Above Base
	MIDDLE DEVONIAN		
	SLAVE POINT FORMATION		
	(14.7 m, incomplete)		
9	Limestone, closely packed lithic grains, medium brown, medium grained, irregularly thick bedded, weathers medium brown and in part stained a yellowish orange, contains fairly numerous macerated organic fragments.		
	Sample 261NBc (GSC loc. 46359) - fossils from unit 9:		
	bulbous stromatoporoid fragment undet. loosely coiled gastropod fragment *Desquamatia (Independatrypa)* sp. cf. *D. (I.) independensis* (Webster) echinoderm ossicle with single axial canal		
	Sample 262NBa (GSC loc. 46322) - fossils from beds approximately equivalent to unit 9 on north flank of syncline:		
	Amphipora? sp. *Desquamatia* (Independatrypa) sp. cf. *D. (I.) independensis* (Webster) echinoderm ossicle with double axial canal	1.1	14.7
8	Limestone, calcarenite, medium to dark brown, fine grained, some scattered sparry calcite, irregularly thick bedded, weathers medium brown, contains sparse poorly preserved atrypids.		
	Sample 261NBb (GSC loc. 46362) - fossils from unit 8:		
	Desquamatia (Independatrypa) sp. cf. *D. (I.) independensis* (Webster) undet. loosely coiled gastropod	1.4	13.6
7	Limestone, closely packed lumplike grains, medium brown, fine grained, granular, evenly and irregularly thin bedded, weathers light brown, transitional contact with unit above.		
	Bedding: 100T/25N.		
	Sample 261NB6 (GSC loc. 46309) - typical lithology	1.7	12.2
6	Limestone, medium brown, medium grained, medium irregularly bedded, with some argillaceous limestone partings, weathers medium brown, contains sparse very poorly preserved atrypids.	0.9	10.5
5	Limestone, closely packed rounded lithic grains, medium brown, fine grained, fairly evenly thick bedded, weathers medium brown, unit highly and irregularly fractured.		
	Sample 261NB5 (GSC loc. 46363) - typical lithology	1.1	9.6
4	Limestone, micrite, argillaceous, colour laminated, light to medium brown, fine grained, evenly thin bedded, fissile, weathers light to medium brown, contains scattered brecciated fragments of limestone up to 1.27 cm in diameter.		
	Bedding: 105T/35N at base of unit 4.		
	Sample 261NB4 (GSC loc. 46372) - typical lithology from top of unit 4.	3.4	8.5
3	Limestone, closely packed lithic grains, colour laminated light and medium brown, fine and medium grained, fairly evenly thin bedded, weathers a light cream-brown, contains irregular laminae of dark bituminous material.		
	Sample 261NB3 (GSC loc. 46373) - typical lithology	1.0	5.1

Unit	Lithology	Thickness	Height Above Base
2	Limestone, medium brown, fine grained, irregularly and evenly medium bedded, weathers medium to dark grey, contains structures suggestive of calcareous algae.		
	Bedding: 108T/37N	1.3	4.1
	Beds of unit 2 are separated by an angular discordance from beds of unit 1.		
1	Breccia: large angular blocks up to 0.9 m in diameter of a variety of limestone types comprising: medium brown, fine-grained, fissile argillaceous limestone; medium brown granular limestone; and laminated light and medium brown, light cream-brown weathering micritic limestone.		
	Sample 261NB1 (GSC loc. 46361) - variety of lithologies.	2.8	2.8

Plate 1

(All figures x40)

Figures 1 - 8. *Polygnathus brevilaminus* Branson and Mehl (Page 35)

All from Slave Point Formation, Section 1, GSC locality C-71457.

1 - 3. GSC 58227, upper, outer lateral, and lower views of Pa element.
4. GSC 58228, inner lateral view of Pa element.
5. GSC 58229, inner lateral view of Pb element.
6. GSC 58230, inner lateral view of Sb element.
7. GSC 58231, inner lateral view of Sc element.
8. GSC 58232, inner lateral view of M element.

Figures 9 - 22, 25 - 27. *Icriodus subterminus* Youngquist (Page 36)

9 - 19. All from Slave Point Formation, Section 1, GSC locality C-71457.

9 - 11. GSC 58233, upper, inner lateral, and lower views of I element.
12. GSC 58234, upper view of I element.
13 - 15. GSC 58235, upper, outer lateral, and lower views of I element.
16. GSC 58236, upper view of I element.
17. GSC 58237, inner lateral view of S_2a element.
18. GSC 58238, inner lateral view of S_2b element.
19. GSC 58239, inner lateral view of S_2c element.

20, 21. GSC 58240, upper and inner lateral views of I element, from Peace Point Member, Waterways Formation, Section 1, GSC locality C-71464.
22. GSC 58241, lateral view of I element, from Peace Point Member, Waterways Formation, Section 2, GSC locality 45977.
25 - 27. GSC 58242, upper, outer lateral, and lower views of I element, from Peace Point Member, Waterways Formation, Section 1, GSC locality C-71467.

Figures 23, 24, 28 - 30. *Icriodus* cf. *I. subterminus* Youngquist (Page 36)

23, 24. GSC 58243, upper and outer lateral views of I element, from Peace Point Member, Waterways Formation, Section 1, GSC locality C-71464.
28 - 30. GSC 58244, upper, outer lateral, and lower views of I element, from Peace Point Member, Waterways Formation, Section 1, GSC locality C-71467.

Figures 31 - 34. *Pandorinellina* cf. *P. insita* (Stauffer) (Page 35)

Both specimens from Peace Point Member, Waterways Formation, Section 1, GSC locality C-71467.

31. GSC 58245, lateral view of Pa element.
32 - 34. GSC 58246, first lateral, upper, and second lateral views of Pa element.

Figures 35 - 39. *Pandorinellina insita* (Stauffer) (Page 35)

35, 37 - 39. All from Peace Point Member, Waterways Formation, Section 1, GSC locality C-71467.

35, 37. GSC 58247 and 58248, respectively, lateral views of two Pa elements.
38, 39. GSC 58249, upper and lateral views of Pa element.
36. GSC 58250, lateral view of Pa element, from Peace Point Member, Waterways Formation, Section 2, GSC locality 45977.

Figures 40 - 44. *Polygnathus* cf. *P. dubius* Hinde (Page 35)

Both specimens from Peace Point Member, Waterways Formation, Section 1, GSC locality C-71464.

40 - 42. GSC 58251, upper, inner lateral, and lower views of Pa element.
43, 44. GSC 58252, upper and lower views of Pa element.

Figures 45, 46. *Polygnathus* cf. *P. pennatus* Hinde (Page 36)

GSC 58253, lower and upper views of Pa element, from Peace Point Member, Waterways Formation, Section 1, GSC locality C-71467.

Figures 47, 48. *Polygnathus webbi* Stauffer (Page 36)

GSC 58254, lower and upper views of Pa element, from Peace Point Member, Waterways Formation, Section 1, GSC locality C-71467.

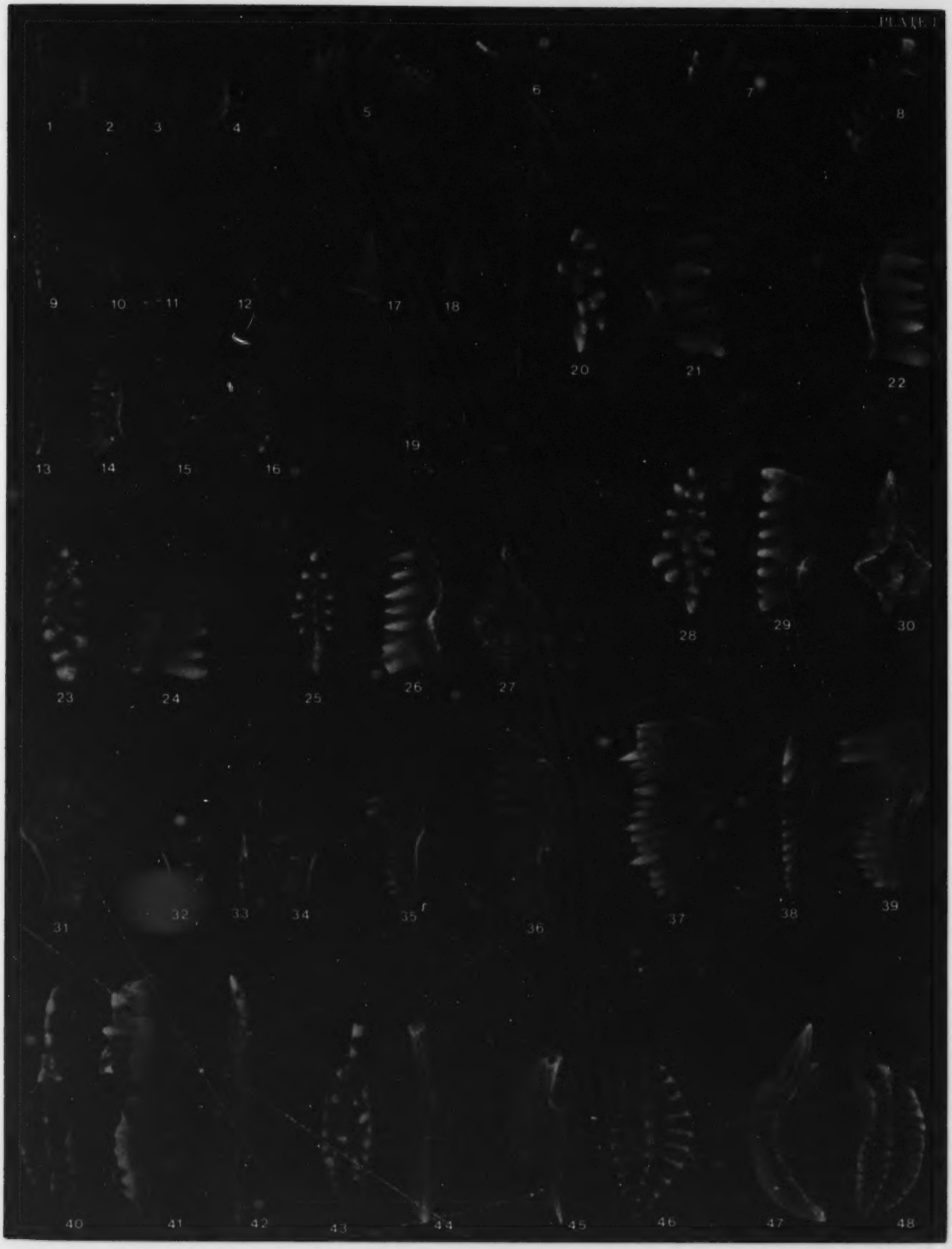
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Plate 2

All illustrated specimens are from the lower beds of the Peace Point Member of the Waterways Formation unless otherwise indicated.

Figures 1 - 22. *Schizophoria lata* Stainbrook (Page 17)

1 - 5. Pedicle, brachial, lateral, posterior and anterior views of a thick young adult individual, x1, GSC 57009, GSC locality C-71460.

6, 7. Pedicle and lateral views of a moderately thin wide individual, x1, GSC 57010, GSC locality C-71469.

8 - 11. Anterior, lateral, brachial and posterior views of a thin adult individual, x1, GSC 57011, GSC locality C-71460.

12 - 14. Lateral, x1, and pedicle (x1, x2) views of a relatively thick wide individual, GSC 57012, GSC locality C-71465.

15. View of interior of pedicle valve of a young individual, x2, GSC 57013, GSC locality C-71469.

16, 17. Views of interior of pedicle valve of a young adult individual, x1 and x2, GSC 57014, GSC locality C-71460.

18. View of interior of pedicle valve of a young adult individual, x2, GSC 57015, GSC locality C-71465.

19. View of interior of pedicle valve of a gerontic individual, x1, GSC 57016, GSC locality C-71460.

20. View of interior of pedicle valve of a gerontic individual, x1, GSC 57017, GSC locality C-71464.

21. Oblique view of interior of brachial valve of a young individual, x2, GSC 57018, GSC locality C-71460.

22. Oblique view of interior of brachial valve of a young adult individual, x2, GSC 57018a, GSC locality C-71469.

Figures 23 - 28. *Schizophoria* sp. cf. *S. allani* Warren (Page 19)

Lateral, pedicle, anterior and posterior views x2, and brachial views x1 and x2, of a young adult individual, GSC 57019, GSC locality C-71463.

Figures 29 - 32. *Strophodonta* sp. (Page 19)

Views of exterior of pedicle valve x1 and x2, views of interior of pedicle valve, x1 and x2, GSC 57020, GSC locality C-71465.

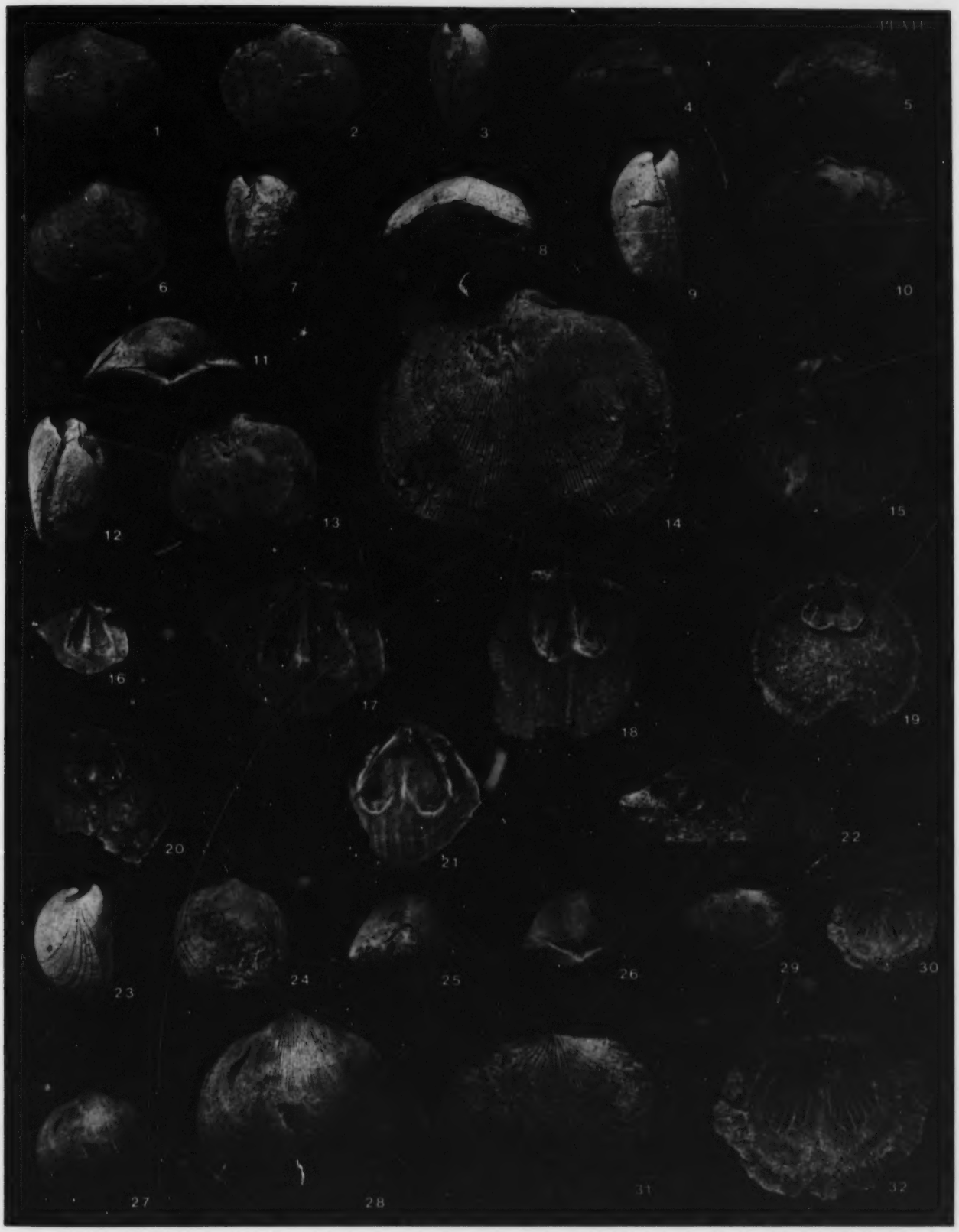
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Plate 3

All illustrated specimens are from the lower beds of the Peace Point Member of the Waterways Formation unless otherwise indicated.

Figures 1 - 37. *Ladogioides pax* McLaren (Page 20)

1 - 10. Anterior views (1, 2), x2 and x3, posterior views (3, 4), x2 and x3, pedicle views (5, 6), x2 and x3, lateral views (7, 8), x2 and x3, brachial views (9,10), x2 and x3, of a very young form, GSC 57021, GSC locality C-71468.

11 - 14. Brachial views (11, 12), x2 and x3, lateral and brachial views (13, 14), x2, of a young form, GSC 57022, GSC locality C-71468.

15 - 19. Lateral, brachial, pedicle, anterior and posterior views, x2 GSC 57023, GSC locality C-71461.

20 - 23. Brachial views, x1 and x2, anterior and lateral views, x2, of a broad young adult form, GSC 57024, GSC locality C-71468.

24 - 27. Posterior, anterior, lateral and brachial views, x1, of a young adult form, GSC 57025, GSC locality C-71468.

28 - 32. Pedicle, x2, brachial views, x1 and x3, lateral and anterior views, x2, of a young adult form, GSC 57026, GSC locality C-71466.

33 - 37. Pedicle view, x2, posterior views, x2 and x1, lateral view, x1, and anterior view, x2, of a thick and narrow form, GSC 57027, GSC locality C-71468.

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Plate 4

All illustrated specimens are from the lower beds of the Peace Point Member of the Waterways Formation unless otherwise indicated.

Figures 1 - 10. *Ladogioides pax* McLaren (Page 20)

1 - 5. Brachial views (1, 2), x1 and x3, lateral and anterior views (3, 4), x1, and pedicle view (5), x3, of an elongate adult form, GSC 57028, GSC locality C-71463.

6 - 10. Lateral, brachial, pedicle, posterior and anterior views of a broad large adult form, x1, GSC 57029, GSC locality C-71463.

Figures 11 - 39. *Platyterorhynchus russelli* McLaren (Page 22)

11 - 16. Pedicle views, x2 and x3, brachial, posterior, anterior and lateral views, x3, of a very young form, GSC 57030, GSC locality C-71466.

17 - 21. Pedicle, brachial, anterior, posterior and lateral views of a young form, x1, GSC 57031, GSC locality C-71466.

22 - 25. Posterior view, x1, brachial views, x1 and x3, and pedicle view, x1, of a thin young form, GSC 57032, GSC locality C-71466.

26 - 30. Pedicle, brachial, lateral, anterior and posterior views, x1, GSC 57033, GSC locality C-71466.

31 - 33. Pedicle, lateral and anterior views of a moderately thin adult form, x1, GSC 57034, GSC locality C-71466.

34 - 38. Pedicle, anterior, brachial, posterior and lateral views of a large thick adult form, x1, GSC 57035, GSC locality C-71463.

39. Oblique view of interior of brachial valve of a young adult form, x3, GSC 57036, GSC locality C-71461.

Figures 40 - 42. *Platyterorhynchus russelli* (McLaren) Form A, new (Page 23)

Lateral, anterior and posterior views of a young adult form, x1, GSC paratype 57037, GSC locality C-71466.

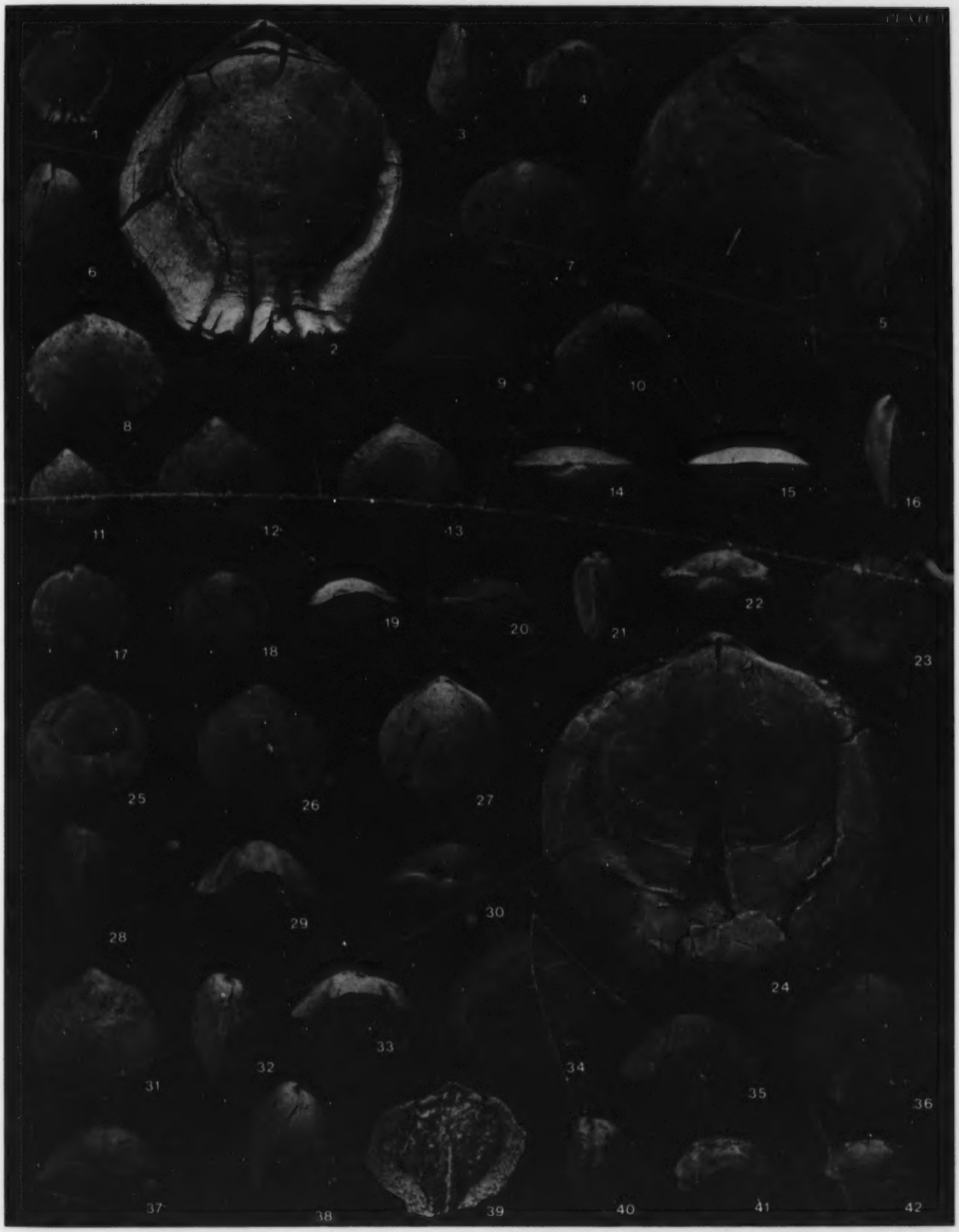
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Plate 5

All illustrated specimens are from the lower beds of the Peace Point Member of the Waterways Formation unless otherwise indicated.

Figures 1 - 7. *Platyterorhynchus russelli* (McLaren) Form A, new (Page 23)

1, 2. Brachial and lateral views of a wide young adult form deformed by crushing at anterior end, x1, GSC paratype 57038, GSC locality C-71469.

3 - 7. Pedicle, brachial, posterior, lateral and anterior views of a wide thick form, x1, GSC holotype 57039, GSC locality C-71466.

Figures 8 - 13. *Pseudoatrypa devoniana boyeri* n. ssp. (Page 29)

Pedicle views, x2 and x3, brachial posterior, anterior and lateral views of a very young specimen, x2, GSC paratype 57040, GSC locality C-71466.

Figures 14 - 33. *Desquamatia (Independatrypa) independensis* (Webster) (Page 24)

14 - 17. Brachial, pedicle, lateral and posterior views of an elongate thick young individual, x1, GSC paratype 57041, GSC locality C-71465.

18 - 21. Lateral, x1, brachial, x2, pedicle and anterior views of a broad relatively thick young adult individual, x1, GSC paratype 57042, GSC locality C-71463.

22 - 24. Brachial, pedicle and lateral views of a very thick adult individual, x1, GSC holotype 57043, GSC locality C-71466.

25 - 28. Brachial, lateral, anterior and posterior views of a broad relatively thin mature adult individual, x1, GSC paratype 57044, GSC locality C-71463.

29, 30. Pedicle and lateral views of a relatively thick rotund mature adult individual, x1, GSC paratype 57045, GSC locality C-71468.

31 - 33. Pedicle, lateral and posterior views of a broad relatively thin adult individual, x1, GSC paratype 57046, GSC locality C-71466.

Figures 34 - 48. *Desquamatia (Variatrypa) clarkei* (Warren) (Page 26)

34 - 39. Pedicle, x1, brachial, x1 and x2, anterior, posterior and lateral views of a young individual, x1, GSC 57047, GSC locality C-71451.

40 - 43. Brachial, lateral, anterior and posterior views of a young adult individual, x1, GSC 57048, GSC locality C-71470.

44 - 48. Anterior, posterior, brachial, lateral and pedicle views of a young adult individual, x1, GSC 57049, GSC locality C-71470.

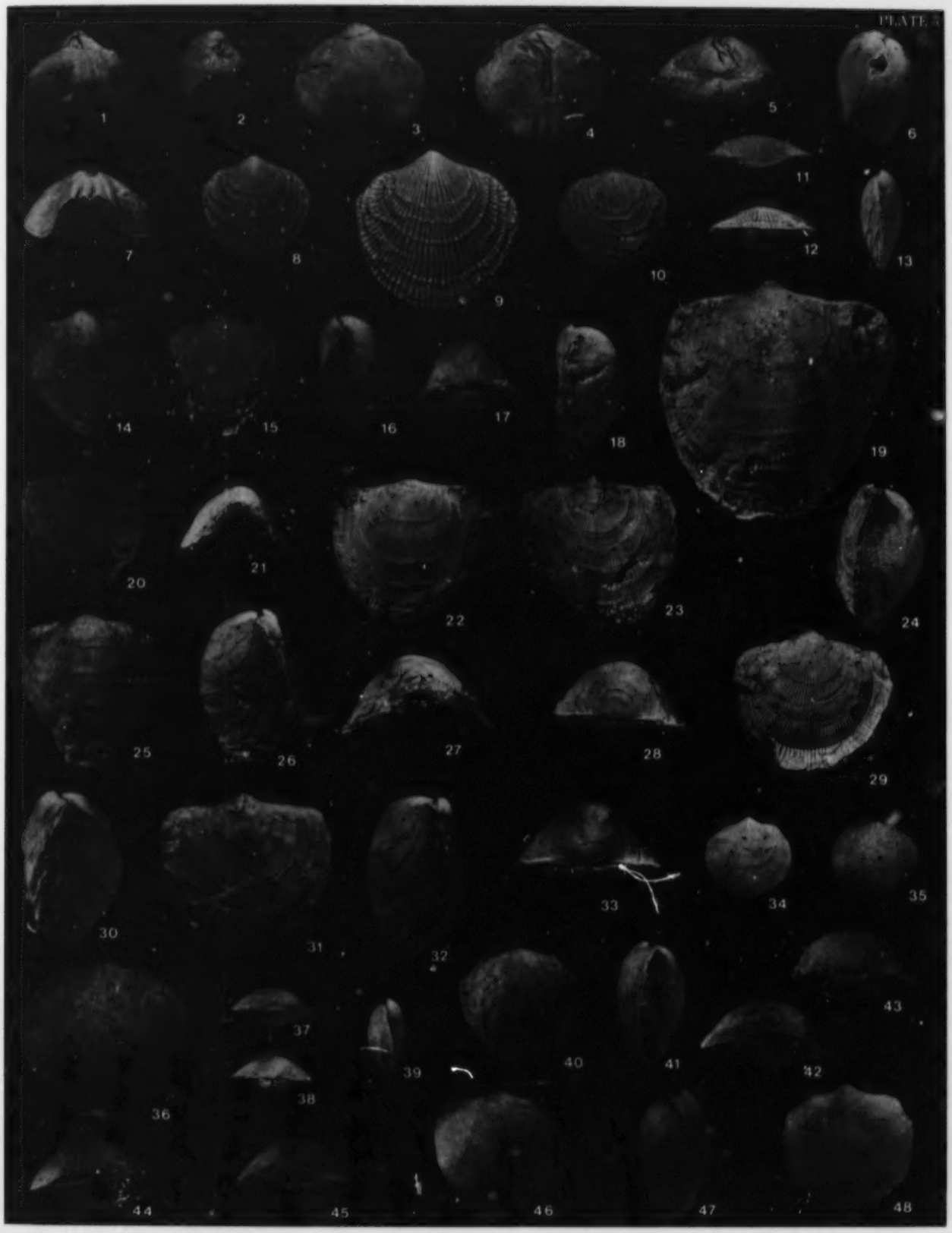
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Plate 6

All illustrated specimens are from the lower beds of the Peace Point Member of the Waterways Formation unless otherwise indicated.

Figures 1 - 6. *Desquamatia (Variatrypa) clarkei* (Warren) (Page 26)

1 - 3. Brachial, lateral and posterior views of a thick adult individual, x1, GSC 57050, GSC locality C-71470.

4 - 6. Brachial, pedicle and anterior views of a thin individual, x1, GSC 57051, GSC locality C-71465.

Figures 7 - 39. *Desquamatia (Variatrypa) klukasi* n. sp. (Page 28)

7 - 11. Brachial, pedicle, lateral, anterior and posterior views of a young individual, x1, GSC paratype 57052, GSC locality C-71463.

12 - 14. Pedicle, lateral and anterior views of a thick young individual, x1, GSC paratype 57053, GSC locality C-71468.

15 - 17. Pedicle, lateral and posterior views of a moderately thick young adult individual, x1, GSC paratype 57054, GSC locality C-71460.

18 - 20. Lateral, pedicle and anterior views of a young adult individual, x1, GSC paratype 57055, GSC locality C-71469.

21 - 23. Pedicle, posterior and lateral views of a planoconvex young adult individual, x1, GSC paratype 57056, GSC locality C-71460.

24 - 26. Pedicle, lateral and anterior views of a thin biconvex young adult individual, x1, paratype 57057, GSC locality C-71463.

27 - 30. Brachial, lateral, anterior and posterior views of a thick subovate adult individual, x1, GSC paratype 57058, GSC locality C-71460.

31 - 34. Pedicle, lateral, posterior and anterior views of a thick planoconvex individual, x1, GSC holotype 57059, GSC locality C-71460.

35 - 38. Brachial, posterior, anterior and lateral views of a large planoconvex gerontic individual, GSC paratype 57060, GSC locality C-71463.

39. View of interior of pedicle valve of a gerontic individual, x1, GSC paratype 57061, GSC locality C-71463.

Figures 40 - 43. *Pseudogruenewaldtia*? sp. (Page 31)

Brachial, lateral, pedicle and posterior views of an adult individual, x1, GSC 57062, GSC locality C-71465.

Figures 44 - 47. *Pseudoatrypa devoniana boyeri* n. ssp. (Page 29)

Brachial views (44 and 46), x1 and x2, anterior and posterior views (45 and 47) of a young rotund individual, x2, GSC paratype 57063, GSC locality C-71460.

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Plate 7

All illustrated specimens are from the lower beds of the Peace Point Member of the Waterways Formation unless otherwise indicated.

Figures 1 - 25. *Pseudoatrypa devoniana boyeri* n. ssp. (Page 29)

1 - 4. Brachial, pedicle, lateral and anterior views of a young thin circular individual, x1, GSC paratype 57064, GSC locality C-71451.
5 - 8. Brachial, lateral, anterior and posterior views of a young thin semicircular individual, x1, GSC paratype 57065, GSC locality C-71451.
9 - 12. Brachial, lateral, anterior and posterior views of a thin semicircular young adult individual, x1, GSC holotype 57066, GSC locality C-71451.
13. Brachial view of a broad thin adult individual, x1, GSC paratype 57067, GSC locality C-71460.
14, 15. Brachial and anterior views, x1, GSC paratype 57068, GSC locality C-71460.
16, 17. Brachial and lateral views of a relatively thick gerontic individual, x1, GSC paratype 57069, GSC locality C-71465.
18 - 20. Brachial, lateral and posterior views of a small elongate thick individual, x1, GSC paratype 57070, GSC locality C-71463.
21 - 25. Pedicle, lateral and brachial views of a small elongate thick individual, x1, anterior view, x3, and posterior view, x1, GSC paratype 57071, GSC locality C-71463.

Figures 26 - 38. *Tecnocyrtina billingsi* (Meek) (Page 32)

26 - 29. Pedicle, brachial, lateral and posterior views, x2, GSC 57072, GSC locality C-71469.
30 - 32. Pedicle, brachial and lateral views, x2, GSC 57073, GSC locality C-71465.
33 - 36. Pedicle, posterior, brachial and lateral views, x2, GSC 57074, GSC locality C-71451.
37, 38. Pedicle valve views, x1 and x2, GSC 57075, GSC locality C-71451.

Figures 39 - 48. *Eleutherokomma impennis* Crickmay (Page 33)

39 - 43. Brachial, pedicle, lateral, posterior and anterior views of a young adult specimen, x2, GSC 57076, GSC locality C-71463.
44 - 48. Pedicle, brachial, lateral, posterior and anterior views of a young specimen, x2, GSC 57077, GSC locality C-71469.

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Plate 8

All illustrated specimens are from the lower beds of the Peace Point Member of the Waterways Formation unless otherwise indicated.

Figures 1 - 4. *Eleutherokomma impennis* Crickmay (Page 33)

1, 2. Views of an incomplete pedicle valve showing micro-ornament, x4 and x2, GSC 57078, GSC locality C-71469.

3, 4. Views of an incomplete brachial valve showing micro-ornament, x2 and x4, GSC 57079, GSC locality C-71451.

Figures 5, 6. *Desquamatia (Independatrypa) independensis* (Webster) (Page 24)

Brachial and pedicle views, x1, of an individual showing scars around the lateral and anterior margins of the shell presumably caused by a boring organism, GSC 57080, GSC locality C-71469.

Figures 7 - 11. *Desquamatia (Independatrypa)* sp. cf. *D. (I.) independensis* (Webster) (Page 26)

Brachial, posterior, pedicle and anterior views, x1, GSC 57081, GSC locality 46322, from 13.6 to 14.7 m above the base of exposure of Slave Point Formation where 14.8 m of Slave Point beds are represented at Section 2.

PLATE 8
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POOR

QUALITY

ORIGINAL